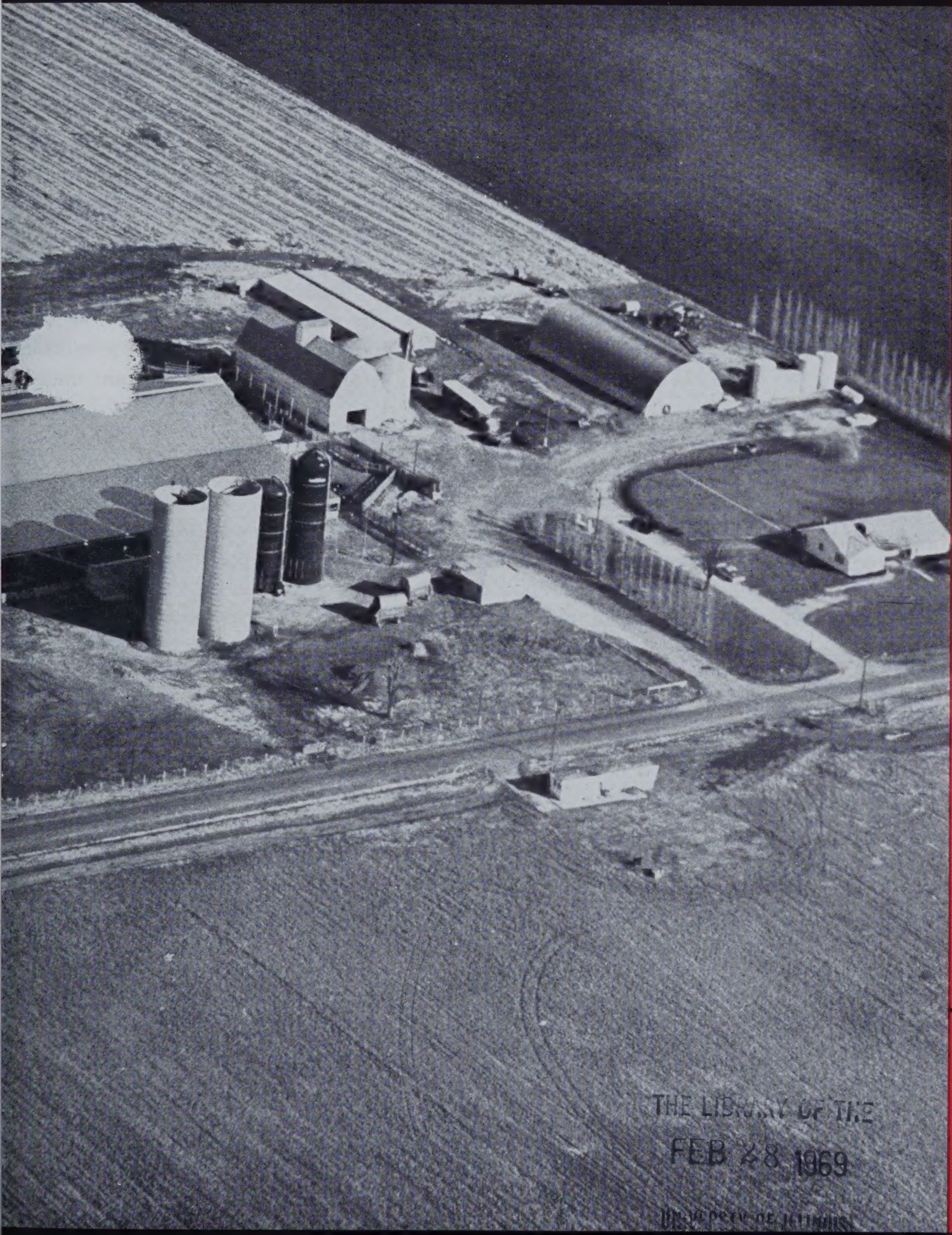
Winter, 1969

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station



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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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THE BROADENING SCOPE OF THE EXPERIMENT STATION AND EXTENSION SERVICE

The research and extension education programs for agriculture, home economics, and forestry at Land-Grant universities have been so successful that they have created a model for the use of science and education in solving societal problems. Along with the evolution of these programs, a philosophy of federal financial support for research and education has developed. The Hatch Act of 1887 authorized payments to the states to encourage the establishment of agricultural experiment stations at the Land-Grant universities. The Smith-Lever legislation of 1914 provided for federal support of the Cooperative Extension Service.

Initially, agricultural research dealt with specific problems primarily related to crop and livestock production and to management of soil and water. As time passed, agricultural problems began to transcend rural-urban boundaries and became part of major questions facing our country. For example, the present concern with environment quality has a great deal of relevance to agricultural production. Agriculture must increasingly concern itself with programs for pollution abatement — especially with the allocation of water (a resource that is becoming increasingly scarce) and the competition for use of land. It is quite apparent that public funds invested in agricultural research and education programs aimed at improving environment quality will have continuing significance, in terms of both the welfare of agriculture and the nation's total scientific and educational effort.

Staff members of the colleges of agriculture have the competencies to make substantial contributions toward solving many problems of national concern. A partial list of these concerns would include not only environmental quality, but also the development of world markets and of world agriculture, conservation of forests and other natural resources, nutrition, home and community life, and the social problems growing out of the changes in rural America.

As the University of Illinois looks ahead to continued growth of its scientific and educational programs, the Illinois Agricultural Experiment Station and Cooperative Extension Service will carry into the future the dual role that they have had in the past: adding to scientific knowledge through research, and interpreting that knowledge in furtherance of a better life for all citizens of our great country. — *O. G. Bentley, Dean of the College of Agriculture*

WHAT IS FARMLAND WORTH?

FRANKLIN J. REISS

LAND IS, for grain farmers at least, the largest single cost item in the farm business. It is also a long-term item in that what is paid for land today becomes a measure of its cost to the business for many years to come.

Land may be owned by the operator, in which case he pays now for all future uses, or it may be rented by the operator — that is, its use is purchased or paid for one year at a time. In either case, deciding what land is worth is a major decision for any farm operator.

Future rights

Investing in farmland is always a forward-looking action. What is bought and sold is essentially a set of rights for a given tract of land — the right to use it, to receive the income from it, to enjoy it, to sell it, or to let it lie idle if one so pleases. The right to exercise these privileges is always in the future. The income to be received from using the land, or payment (rent) for letting someone else use it, is future income. In fact, it may be thought of as a continuing series of annual incomes, a stream of income payments, stretching without end into the future.

When we think of land strictly as farmland, with no other likely uses, it is this income stream from farming that gives the land its value. The price of land is, in effect, the current value that buyers and sellers place on the stream of future income. If there is reason to believe that the annual incomes in this stream will increase in the future, then, presumably, buyers should be willing to pay more now for the right to receive these higher future incomes.

Franklin J. Reiss is Professor of Farm Management and Land Economics, Department of Agricultural Economics.

Buyer expectations

When land buyers expect an increase in earnings from land, the price of land rises relative to land earnings in the present and the recent past. We then say the capitalization rate has gone down, by which we mean that buyers are willing to take a lower rate of return on their money.

This explanation, however, is not quite adequate. Buyers probably still expect a normal return on their money, but they figure on a long-term basis. They expect that higher returns in the future will make up for what they sacrifice at present. Or they count capital gains (increases in the value of land) as part of their current returns.

Prudent land buyers also consider the cost of investing in farmland. This is a matter of interest rates. If an investor must borrow part of the purchase price of a tract of farmland, then the interest he must pay becomes an out-of-pocket cost against the expected future incomes. But this is not his only interest charge. The money he already has, his equity in the purchase price, has other possible uses in which it would earn a return — possibly a higher one. The return that he forgoes is the opportunity cost of using these funds to buy land.

The buyer controls the ratio (rate of return) between his costs and the expected returns from the land by raising or lowering the price he is willing to pay now for future incomes. In other words, the value now of a stream of income in the future is the sum of those expected annual incomes after each one has been discounted to its present worth at the long-term rate of interest which the buyer wants on his money

Where we are now

If we assume that mortgage interest rates represent the cost of investing in farmland or, conversely, that they represent long-term returns expected from farmland, then clearly buyers have been expecting much higher net dollar returns to land in the future. Mortgage rates of 6.5 to 7 percent on a purchase price of $900 per acre imply *average net returns* of $58.50 to $64 an acre. We haven't been anywhere near such returns on even the best central Illinois farmland under typical management.

Average net rents per tillable acre received by landlords on rented farms enrolled in the Illinois Farm Business Farm Management Service, a cooperative record-keeping project, have been rising over the past eight

to ten years, and in 1966 they were at the highest dollar figures since the close of World War II. According to these records, the typical tenant farmer on good, east central Illinois soils produced crops that netted the landlord about $35 per acre of cropland. Some farms that were able to produce $130 to $150 worth of crops per tillable acre returned net rents of $40 to $45. Paradoxically, however, the large crops of 1967 caused lower product prices and a $1 to $4 decrease in net rents per tillable acre.

The "typical" operator may have lost his dominant influence in the land market. Increasingly, the men who are buying land fall into one or more of the following categories: (1) those who are able to pay a premium for land for farm-enlargement purposes; (2) those who are pricing land for future nonagricultural uses (that includes those who buy farmland to trade for land desired for non-agricultural purposes); (3) those who already own land and can borrow more dollars against their expanding equities in a rising land market; and (4) those who are able to make land earn more than others can.

The case for higher land prices

Will farmland prices rise still higher? Four prospects seem to make up the strongest argument for an affirmative answer. They are (1) expanding domestic and world population, (2) higher crop yields, (3) monetary inflation, and (4) government price and income supports. Upon close examination, however, none of these four appears to be an unequivocal indicator of rising prices.

Human population is still showing an absolute increase. But the rate of increase appears to be headed downward, while the rate of increase in agricultural output may be headed upward, at least for certain developing nations and the United States. The rate of U.S. population growth is substantially below the average rate of increase in U.S. agricultural production. Moreover, potential increases in food consumption among poverty groups in U.S. society are not likely to absorb all prospective surpluses in domestic production. According to recent projections of U.S. farm production trends and of domestic and export demand up to about 1980, we will continue to have surplus agricultural production capacity and a need for land-retirement programs.

The case for higher farmland prices seems to depend most on the prospects for continued monetary inflation. The question seems to be not so much one of whether such inflation will occur, but one of how much inflation we are likely to have. Even then, there remains a question of whether farmland prices will rise in proportion to the general price level. It could be that inflationary forces will affect costs of farming (other than land costs) more than farm product prices, and that net returns to land will not rise in proportion to increases in other prices. Substantial inflation would, of course, carry farmland prices along with it.

Reducing or stabilizing factors

We have already noted that the farmland market is forward looking. In evaluating forces that may influence the expectations that potential buyers hold, it will be helpful to recognize that some will have an immediate impact while others become effective in the somewhat distant future. The outline below recognizes this time element, but does not attempt either to chart the course of future events or to measure their intensity.

Factors with an immediate effect on land prices are:

1. High mortgage interest rates.
2. Rising farm operating costs, including higher imputed returns to the farm operator's labor and management.
3. Decline in farmer optimism.
4. Higher absolute equity requirements than in the recent past.
5. High and rising property taxes.
6. Lower prices for farm products.

Long-term factors are:

1. "Land substitutes" in the form of new production technologies.
2. Synthetic foods and fibers.
3. Possible decline in competition for land as farms grow larger and farmers fewer in number.
4. Economic limits on the size of farms.

Admittedly the long-term factors, by their very nature, do not have much effect on current land prices. And even the short-term factors lag in their influence because their effect is primarily on the buyers' and sellers' expections of future returns to land.

Conclusions

Currently there are strong tendencies to see land as a scarce, nonreproducible good, and to price it for the future income and security its possession seems to offer. On the other hand, we are rapidly recognizing that we live in an urban culture with people who have no close or direct family ties to land. Such people view land matter-of-factly as an economic resource or as a public facility, and to them its price should be in line with the demand for its products and services.

Summing up the land situation today, we can discern three major present and future trends:

1. Farmland in much of Illinois probably has been overpriced in the past five years. We need a period of stable land prices, with possibly some downward adjustments where these have not yet occurred, to make better observations and to reformulate sounder expectations concerning the future need for and probable returns to farmland as farmland.
2. Distinctions will be more sharply drawn between the value of land that can be farmed extensively with large-scale methods and land which if it is to be used for farm purposes at all, must remain in small fields and possibly in less intensive uses than it had in the hands of relatively small individual operators.
3. Location will be a major factor in valuing land because the "space contribution" to human life will become more important relative to the physical products that the land can produce.

Gluing the subfloor of a new house in Champaign-Urbana.

Strengthen a New House by Gluing the Subfloor

DONALD H. PERCIVAL

HOUSES of the future may have sturdier, stiffer floors as the result of using an adhesive in attaching the plywood subfloors.

This use of adhesives is still in the experimental stage, but results so far have been encouraging. Not only have floors been strengthened and stiffened, but squeaks between the joists and subfloors have been eliminated, and nail-popping problems have been reduced.

Gluing subfloors is an extension of currently accepted structural gluing practices, such as are used in roof trusses, box beams, and laminated arches. In both research studies and commercial use, a rigid connection, stronger than the wood itself, can be developed with the correct use of structural adhesives. Usually a glued component is stronger and stiffer than the individual pieces comprising the component.

Research by several agencies

Research to examine the effect of glued subfloor attachment in home construction has been conducted by several agencies: the Small Homes Council–Building Research Council, University of Illinois; the USDA Forest Products Laboratory, Madison, Wisconsin; the Research Laboratory of the National Association of Homebuilders; and the American Plywood Association.

In the University of Illinois study, standard casein-bound adhesive was applied in a strip along the top edge of each joist just before the plywood subfloor was nailed. The glue made the plywood and joist act as a T-beam, or as one member, definitely increasing the strength and stiffness of the floor. The load distribution to adjacent members was spread over a larger area than in similar test units without the adhesive.

Because of limitations inherent in the mixing, application, and curing of casein glue, however, it is not generally accepted by code authorities and lending agencies for field application. Several manufacturers have therefore undertaken further research to develop adhesives that can be used in cold weather and that do not present mixing or clean-up problems. These adhesives are also being designed to fill the gaps between the unsanded members being glued, thereby reducing potential sources of squeaks.

Use by contractor

A Champaign-Urbana contractor recently used one of these new adhesives to glue the subfloor of the first floor of a new two-story house. The adhesive was applied to the top edges of the floor joists by forcing it from a cartridge with a large caulking gun. The first floor, applied with adhesive, will be compared with the second floor, which was nailed only. Regular observations will be made of future performance.

While the glue was being applied, the Small Homes Council–Building Research Council conducted a time and cost study. Four men applied the subfloor (28 sheets of plywood), requiring a total of 180 man-minutes. Forty man-minutes were needed to apply the adhesive; the rest of the time was spent in handling, cutting, positioning, and nailing the plywood. A compressed-air power nailer was used to nail the plywood after the adhesive was applied.

The estimated cost of the adhesive for this floor area, 900 square feet, was about $20. With the 40 minutes of carpenter's time required to apply the adhesive, one could estimate that gluing the subfloor would add about $25 to the cost of a house.

Further information can be obtained by writing to the Small Homes Council–Building Research Council, University of Illinois at Urbana-Champaign, 1 East Saint Mary's Road, Champaign, Illinois 61820.

Donald H. Percival is Associate Professor of Wood Technology and Utilization, Department of Forestry and Small Homes Council–Building Research Council.

Effects of Storage Time and Temperature on Fertility of Bovine Spermatozoa

G. W. SALISBURY,
J. R. LODGE, and
C. N. GRAVES

Besides benefiting dairymen, studies on spermatozoan storage may expand our knowledge about the aging process and the storage of human organs for transplants

THE MAINTENANCE of fertility by bovine spermatozoa during extended storage at several temperatures has been the subject of long-continued research in the Department of Dairy Science.

Basically, the investigators (the authors and their graduate students) have sought an answer to this question: How long can we achieve a normal reproductive rate through artificial insemination if, before use, the spermatozoa are stored at increasingly cooler temperatures?

The answer is becoming increasingly important to Illinois dairymen, since artificial insemination is now the preferred method of breeding more than half the dairy cattle in Illinois. The information will also benefit others who use artificial insemination as the primary way of breeding animals.

The studies have followed two related and parallel lines of inquiry. First, a reasonable answer had to be found for the limits of practical fertility during storage of male gametes at different temperatures. Evidence was found in these studies for the hypothesis that changes in the genetic material carried by the spermatozoa placed limitations on maintaining their fertility forever.

Second, it was then necessary to study the changes occurring in the genetic material. Perfection of techniques for determining the nature of such changes has been more difficult than has been the determination of the practical time limits. Some of the limitations to the preservation of an infinite life are now known, but the ultimate answer is not yet in sight. Nevertheless, from the investigations, we have obtained new insights into the complexities of nature and the biological mechanisms involved in survival of mammalian species.

G. W. Salisbury is Professor of Dairy Science and Head of the Department; J. R. Lodge and C. N. Graves are both Associate Professors of Physiology, Department of Dairy Science.

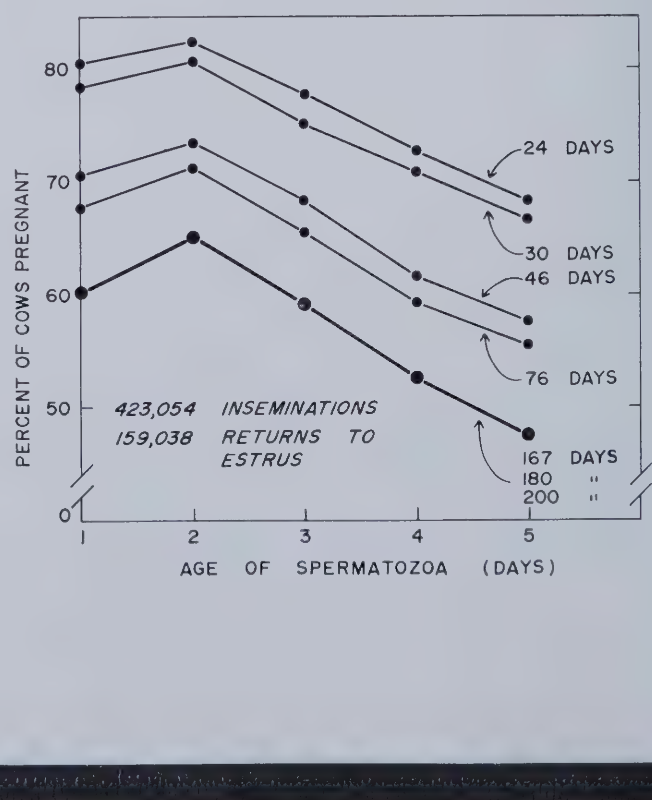
Three storage temperatures

Practical limits have now been set for the time that spermatozoa can be expected to remain fertile during storage at three markedly different temperatures. The use of these temperatures has paralleled the development of three techniques for storage of bovine spermatozoa: (1) storage at normal refrigerator temperature, or about 4° C. above the freezing temperature of water; (2) storage with solid carbon dioxide (dry ice) in acetone or alcohol maintaining the temperature at −79° C.; (3) storage at −196° C. in liquid nitrogen storage equipment, which is now commonly used.

For practical reasons, the limits of attempted storage were about 10 days for 4° C., one year for −79° C., and two years for −196° C.

Storage at 4° C.

The first studies, in cooperation with the Southern Illinois Breeding Association at Breese, established in some detail the limitations for maintaining optimum fertility of spermatozoa stored in a suitable medium at 4° C. Cows were inseminated with spermatozoa which had been in stor-



How number of pregnancies in cattle was affected by age of spermatozoa and the length of time after insemination.

ıge for varying numbers of days. Al- ogether 423,054 inseminations were nade over a period of 3½ years.

The percentage of pregnancies was letermined 24 days after insemina- ion. Later assays were made 30, 46, 76, 167, 180, and 200 days after in- emination to determine the number of continuing pregnancies. No matter when the assays were made, the max- mum percentage of pregnancies re- ulted from the use of spermatozoa in he second day of storage. Thereafter ertility declined in a straight line.

Results for spermatozoa stored up o 5 days are shown in the chart on page 6. The number of inseminations rom spermatozoa stored more than days was too small to estimate fer- ility reliably. These results showed hat during storage fertility increased o an optimum which was maintained nly a short time and then decreased n a predictable fashion.

Colder storage

Nearly 20 years ago it was dis- overed in England that spermato- oan fertility could be preserved by dding the chemical substance glyc- rol to the suspending medium dur- ng freezing, and lowering the tem- erature to −79° C. With this iscovery the hope was generated hat the fertile life of spermatozoa night be preserved for an infinite eriod of time.

From the available knowledge of he effect of decreasing temperature n metabolic energy exchange and he motility of the spermatozoan tail, was reasoned that these functions ould be markedly slowed or stopped hen the spermatozoa were frozen nd stored at −79° C. On the basis f changes known to occur at tem- eratures above freezing, it was cal- ulated that spermatozoan life should e extended 250 or more times at −79° C. and by an additional 1,000 mes when the temperature was de- reased to −196° C.

According to the results from de- igned experiments, the colder tem- eratures do extend the fertile life of tored spermatozoa, but not as much s expected. Bull spermatozoa stored t −79° C. reached optimum fertility in the first month of storage after the month of collection, or after about 48 days of storage. Fertility decreased slightly during the next three months, after which it began decreasing more rapidly.

Spermatozoa stored at −196° C. reached optimum fertility in the fourth month of storage. This level was maintained through the eleventh month and then began to decline.

Increased losses

It is known that changes in the genetic material of spermatozoa (for example by x-irradiation) may increase embryonic and early fetal losses. According to our data, the loss of fertility during storage is accompanied by an increase in apparent embryonic and fetal deaths in cattle.

In studies of the storage of rabbit spermatozoa, decrease in spermatozoan fertility was accompanied by a measurable increase in dead embryos found on examination of females. In more extensive studies of the storage of frog spermatozoa, proof has been found that the genetic material (the DNA → RNA → protein sequence) has in fact been changed, leading to an arrest of embryonic development.

According to more recent studies, the genetic material of these gametes undergoes continuing metabolic exchange even at the very lowest temperatures studied. During storage of bull spermatozoa, measurable changes occur in the protein of the DNA protein complex in the sperm nuclei.

Implications of results

In addition to establishing the limits for storing spermatozoa to be used in artificial insemination, the results of the studies reported here have implications for other problems as well. These results, for example, may open new avenues for the study of limitations on the effective storage of any living tissue, including organs for transplants in humans.

Also, during the collection of evidence on the fertility of cattle, rabbit, and frog spermatozoa, knowledge has been gained of certain basic chemical and physical changes in spermatozoa as they age. This knowledge may result in a better understanding of the aging of all cells and tissues.

Within the past 10 years scientists interested in the aging of man have developed a number of theories as to the basic causes for the physiological changes that occur during aging. Among these speculations, a theory of "wear and tear" on cells and tissues of the body has been contrasted with a theory that specific genetic mutations cause the aging process.

It is difficult indeed to determine that the functional breakdown of a body comprised of multicellular tissue may be due to mutations in the DNA of the nuclei of individual cells. The senior author therefore speculated in 1965 that, to test the contrasting theories, the number of cells involved in the test situation must be simplified. This simplification occurs when a single spermatozoon fertilizes a single egg. Such an event provides an opportunity for studying the possibility of a genetic mutation.

Many environmental conditions can be imposed on gametes to prevent fertilization. Conditions that would permit at least a minimum of normal fertilization were required for studies of genetic mutation. In the studies described in this paper, the spermatozoa were aged just enough that their ability to enter the ovum and to initiate the first steps in embryo development was slightly depressed. Observations of a number of frog embryos, plus a few rabbit embryos, indicated that many of them had been seriously impaired by the aging of the male gametes.

Since the primary contribution of the spermatozoon to a new individual is the male genetic message, a change in that material is the suspected site of the damage caused by aging. So far the only clear evidence supporting this theory has been provided by the experiments with aging of frog spermatozoa. Experiments are now in progress to test the theory for the higher animals. The work may not provide evidence eliminating other causes of aging, but it may provide good evidence that genetic damage is at least one of the causes.

Good Peformance From Beef Cows Confined to Drylot the Year Round

W. W. ALBERT

Measuring feed to drylot cows.

WITH THE TREND toward continuous cropping of corn or soybeans, the summer pasture and hay once traditionally used for beef herds have been eliminated on many farms. Most of these farms, however, still produce large amounts of cornstalks and bean stubble which beef cows are capable of utilizing as winter feed.

This situation has raised a question as to whether beef cows can be confined with satisfactory results during the pasture season or even the year round. To answer this question, the Department of Animal Science began a study in 1963 of the nutrition, reproduction, and overall performance problems associated with confinement handling of beef cows.

Table 1. — Services Required per Conception per Cow

Year	Number of services	
	Drylot	Pasture
1964	1.63	. . .
1965	1.46	1.80
1966	1.54	1.63
1967	1.27	1.81

Every year since 1963, about 22 Shorthorn cows have been confined the year round in drylot. After the first year, the performance of the drylot cows has been compared with that of 11 cows pastured from May 15 to October 15 and fed in drylot for the other seven months. The pastures have been 1963 seedings of bromegrass, orchardgrass, and alfalfa.

A spring calving program has been followed, and the breeding season, using natural service, has been from May 15 to September 1. Calves have been creep-fed and have been weaned about October 1.

Reproduction and weaning weights

The best economic measures of cow productivity are regular breeding and the weaning of a heavy, quality calf. During the breeding season all cows were checked for estrus each morning and evening. Fewer services were required per conception for drylot cows each year than for pasture cows (Table 1). It has been suggested that a more uniform energy supply in drylot may account for this improved conception.

Table 2. — Average Weaning Weights and Creep Feed Consumption per Calf

Year	Actual weight, lb.		Weight adjusted to 205 days, lb.		Average feed consumed, lb.	
	Drylot	Pasture	Drylot	Pasture	Drylot	Pasture
1964	413	. . .	485	. . .	461	. . .
1965	490	444	477	466	627	571
1966	486	492	532	520	703	629
1967	555	540	545	546	748	726

Table 2 shows both the actual average weaning weights of calves and weights adjusted to 205 days according to the Illinois Performance Testing Program. While a commercial producer is interested in actual pounds of salable calf, the adjusted weights equate differences due to age and sex of calf, and age of dam.

Average actual weaning weight of drylot calves was 46 pounds above that of pasture calves in 1965, 15 pounds greater in 1967, but 6 pounds less in 1966. On an adjusted basis, drylot calves were 11 pounds heavier than pasture calves in 1965; 12 pounds heavier in 1966; and practically the same as pasture calves in 1967. Drylot calves ate an average of 56 pounds more creep feed than pasture calves in 1965; 74 pounds more in 1966; and 22 pounds more in 1967 (Table 2).

The drylot calves' marked increase in creep feed consumption from 1964 to 1965 is attributed to the change in creep formulation (Table 3). The heaviest creep consumption occurred in 1967 and was reflected in heavier weaning weights.

The question is sometimes asked, "Is creeping worthwhile?" According to a two-year summary of Illinois performance records on 2,000 calves, those that were not creep-fed had an average 205-day adjusted weight of 407 pounds. The average actual weight of the drylot calves in 1965

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Table 3. — Creep Feed Composition

Ingredient	Percent
In 1964	
Oats, crimped	60
Corn, cracked shelled	30
Linseed pellets, 36%	10
Since 1965	
Oats, crimped	40
Corn, cracked	30
Soybean meal, 50% C.P.	20
Alfalfa, dehydrated	4
Molasses, dried	4
Phosphate, dicalcium	1
Salt, trace-mineralized	0.5
Aurofac-10	+[a]
Vitamin A	+[b]

[a] Twenty grams per ton.
[b] 4,540,000 I.U. per ton.

Table 4. — Approximate Daily Rations for Drylot Cows, 1965-1968

Roughage and aver. dates fed	Lb.	Cost per lb.[a]	Days	Value
Cornstalk silage (11/1 — 2/15)	40	$.0035	107	$14.98
Corn silage (2/16 — 6/30)	45	.0045	135	27.34
Haylage (7/1 — 10/31)	35	.0050	124	21.53
Total value	..	...	...	$63.85

[a] At a cost per ton of $7 for cornstalk silage; 9 for corn silage; and $10 for haylage.

and 1966 was 488 pounds, which means that 81 extra pounds could be attributed to creep feeding. Average consumption of creep during the two years was 665 pounds. At 3 cents per pound, the average feed cost for each calf was $19.95. The cost of each pound due to creep feeding was thus 24.6 cents ($19.95 ÷ 81). In recent years choice calves averaging 450 to 450 pounds have sold at well over 28 per hundredweight.

Roughage rations

The kinds, amounts, and costs of roughage fed in drylot from 1965 to 1968 are shown in Table 4. Nonprotein nitrogen supplements with urea, dicalcium phosphate, and trace-mineralized salt were added to corn forages at ensiling to formulate balanced winter rations of about 11 percent crude protein. Additions of 75 pounds of dried molasses and 75 pounds of corn meal were made to each ton of stover silage. The values given in Table 4 for corn silage and stover include the ensiled additives and nonprotein supplement costs.

The 365-day roughage cost for each drylot cow was $63.85 (Table 4). If the cows had been fed hay, the bill would have been $76.65 (based on a daily consumption of 21 pounds per cow and a hay price of $20 per ton).

Pasture cows remained on grass from about May 15 to October 15. Table 5 gives the number of cow-days per acre from feeding haylage and from grazing an equivalent acre of pasture. The use of forage as haylage increased carrying capacity by about 47 percent.

Summer weight changes of cows

Individual cows were weighed at the first of each month. In general, drylot cows gained more during the summer than cows on pasture (Table 6). Much of the drylot cows' advantage was doubtlessly due to their consumption of corn silage. All cows received the same rations during the winter.

Health of herds

Health of the cows has been satisfactory. During four years one cow died in drylot, with the diagnosis of heart failure, and another cow was sold with diagnosed symptoms of hardware disease. One pasture cow was sold with suspected symptoms of Johne's disease, and a second cow was culled because she did not conceive after 18 months.

The hooves of all cows were trimmed during the 1967 summer. Some cows in drylot had long toes, and generally the hooves of these confined cows showed less wear than those of the cows on pasture.

The calves were also in satisfactory health. During the first summer hair coats lacked luster, but since reformulation of the creep in 1965 hair coats have shown good bloom. During this study, five calves (including one in 1968) were lost because of scours. These deaths occurred before the calves were three weeks old. Several measures have been taken to minimize scours: Only hay has been fed to cows for two weeks after calving, since a too-abundant milk flow before the calf is about three weeks old seems to contribute to scours. The cow and calf have been placed outdoors on a sod pasture for two weeks after calving. And cows with calves of similar ages have been grouped together for several weeks after calving.

Since 1963 two virus pneumonia epidemics have occurred — both in early April during wet cool weather. Barn conditions seem to favor transmission of the virus. The incidence was decreased when calves were forced to remain outdoors.

Advantages of drylot operations

Important economic considerations in cow operations include input of man hours and capital investments in feed structures. It would seem that an automated silo system might reduce labor and also insure greater nutrient yield per acre. A good manager will make a daily check of cows on pasture, fences, and water. In a drylot program, checking could be done while roughage is being automatically delivered to the bunks.

Under many farm conditions, the combination of drylot and grazing may be more flexible than drylot alone. A combination system may be most useful for producers who don't have permanent or rotation pasture, but who wish to use beef cows to glean cornstalk and stubble fields.

Table 5. — "Cow Days" per Acre of Forage

Year	Number of cow days		Percent difference
	Haylage	Pasture	
1965	363	205	44
1966	441	239	46
1967	450	217	50

Table 6. — Average Pound Increases per Cow, May 15 to October 1

Year	Date to which corn silage was fed in drylot	Lb. of gain per cow	
		Drylot	Pasture
1964	....	39	..
1965	June 15	42	37
1966	July 4	58	12
1967	August 1	87	10

SWEET CORN DEVELOPMENT

As Affected by Environment and by Inherent Differences Among Hybrids

CHARLES Y. ARNOLD

In a recent study of sweet corn hybrids, inherent differences among eight of the hybrids accounted for a spread of 18 days in the time required to reach maturity.

The study concerned the effects of both heredity and environment on the development of the plant. It was undertaken because the time required for sweet corn to reach critical stages of maturity is of great concern to producers of sweet corn for the fresh market, processors, and seed producers. Following are some of the highlights of the study.

Hybrid comparisons

The time pattern for the development of the eight hybrids is shown in Figure 1. The time values are averages from 11 plantings which have been adjusted to minimize the effect of temperature, and thus reflect primarily the influence of inherited characteristics.

The hybrids are listed in order of the time required to reach tassel initiation. This event is the first indication of a switch from vegetative to reproductive development. On the average, it occurred when only 28 percent of the time to harvest had transpired. There was a 9-day spread among the hybrids, which was 50 percent of the spread that would occur at harvest. The aboveground appearance of the plants, however, gave no indication of this spread in development.

By the time of pollen shed, an average of 69 percent of the time to harvest had transpired. The spread between the extremes had increased to 16 days, or 86 percent of the spread at harvest. The time pattern among the eight hybrids had also become modified, as they did not reach pollen shed in the same order that they had reached tassel initiation.

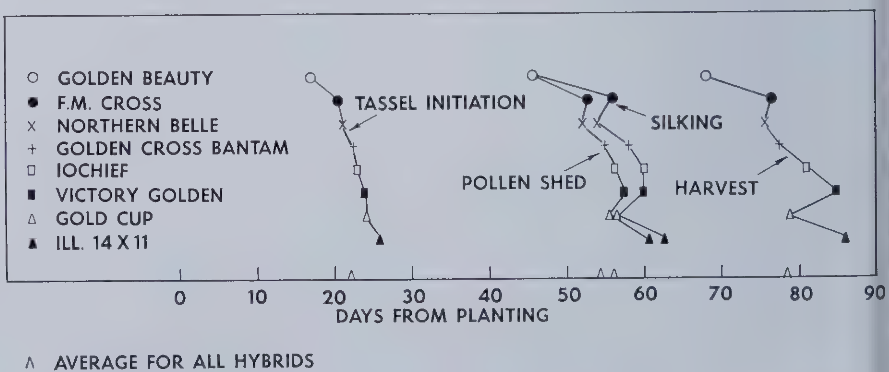
Differences in the time from pollen shed to silking ranged from 0.2 to 3.7 days and resulted in a further modification of the pattern. The time required between silking and harvest ranged from 20 to 25 days and showed no relationship to the time required from planting to silking.

The time pattern at the time of tassel initiation and its progressive modification at later stages of development was found to be associated with inherited characteristics. The primary developmental activity between planting and tassel initiation is the production of leaves. The total number initiated in this period ranged from 12 on Golden Beauty to 18 on Ill. 14 x 11. It follows that the time to tassel initiation was related to the total number of leaves on the hybrids.

At this stage of development, however, vegetative growth was not complete. Almost no internode elongation had taken place, the growing point was still underground, and only 46 percent of the leaves were visible. The additional vegetative growth that was required, like the growth preceding tassel initiation, was correlated with the total number of leaves. As a consequence, the time to pollen shed and silking was also correlated with leaf number. Each additional leaf increased the time by 2.2 days.

The time to these two stages of development was further modified by the weight of the tassel and the length of the ear. Gold Cup, for example, was ranked seventh at tassel initiation, but, by virtue of its small tassels and short ears, it was ranked fifth at pollen shed and fourth at silking. Differences in the time from silking to harvest were influenced by yield and percent oil of the kernels at harvest time.

In addition to the physical characteristics mentioned above, an inherent difference in the rate of development also influenced the time pattern through every phase of de-



Days required for eight hybrids to reach various stages of development. (Fig. 1)

Charles Y. Arnold is Professor of Vegetable Crops, Department of Horticulture.

'he response of this Central American weet corn variety to increased day length ividly illustrates the effect of photo-eriod. (Fig. 2)

elopment. It was detected in the ate of leaf appearance between the ourth and eighth leaf stage. A rela-ve rate index was calculated and anged from 106 for F. M. Cross to 2 for Victory Golden. As indicated n Figure 1, these hybrids reached arvest eight days apart. If they had een growing at the same rate, this ifference would have been cut to ne day.

nvironmental influences

The overall effect of temperature n the rate of development of sweet orn was found to be a complex one n which the relationship changed om one phase of development to nother.

At least up to the fourth leaf age, the rate of development in-reased steadily with increasing tem-eratures above 43° F. During this period the rate was more closely associated with soil temperature than with air temperature.

Between the fourth leaf stage and silking, the relationship changed to one in which there was a zero rate of development at about 50° F., a maximum rate at about 80° F., and a zero rate at about 100° F. Following silking, the relationship reverted to one in which the rate increased steadily as temperatures rose above 38° F.

The magnitude of this temperature effect can be illustrated by the fact that different plantings of Victory Golden have taken from 48 to 70 days to go from planting to silking, and from 20 to 32 days to go from silking to harvest.

The picture is further complicated by the influence of environment on plant characteristics. This is exemplified by the results of one experiment in which we produced two sets of plants of the same hybrid. One set was treated with cool temperatures from the fifth leaf stage to tassel initiation and the other set was treated with warm temperatures (Table 1). Plants treated with cool temperatures had an average of 14.5 leaves; those treated with warm temperatures, 17.3 leaves.

If we had been comparing different hybrids with these leaf numbers, we would have predicted that the set with 17.3 leaves would initiate tassels 4 days later and shed pollen 6 days later than the set with fewer leaves. But, in this experiment, these events occurred about the same time. The explanation lies partly in the fact that the set in the warm chamber was making more vegetative growth during the period of treatment, as evidenced by the number of leaves appearing. As a result, the warm-treated set had about the same amount of vegetative growth to complete as the cool-treated set at the time of tassel initiation.

Another experiment concerned the effect of photoperiod, or length of daylight, on five varieties. The varieties were chosen on the basis of their adaptability in areas where different photoperiods prevail during the growing season. Alaskan Acc. 6246 grows well under the long summer days at high latitudes. Golden Beauty, Golden Cross Bantam, and Ill. 14 x 11 are adapted to the intermediate day lengths of Illinois summers. Major Belle is grown in Puerto Rico, where days are short.

The time required for the first four varieties to reach critical stages of development was not affected by day length. Major Belle, however, responded with an increase of 6.3 in leaf number and a 3-week delay in pollen shed when day length was increased from 10 or 13 hours to 16 hours (Table 2). At tassel initiation, the growing point, which is normally underground at that stage, was 29 inches aboveground.

Considering the complexity of the hereditary influences, the environmental influences, and their interaction, it is no wonder that the prediction of critical stages of development still remains a major problem in sweet corn production.

Table 1. — Effect of Temperature From Fifth Leaf Stage to Tassel Initiation on Development of Golden Cross Bantam Sweet Corn[a]

	Cool temperatures	Warm temperatures
Day and night temperatures[b]	70°-55° F.	95°-80° F.
Leaves appearing during treatment	1.5	3.3
Total leaves	14.5	17.3
Days to tassel initiation	20	21
Days to pollen shed	48	47

[a] Plants were grown in the greenhouse up to the fifth leaf stage, transferred to plant growth chambers until tassel initiation, and then returned to the greenhouse.
[b] While in the growth chambers, plants had 14 hours of light and 10 hours of dark.

Table 2. — Effect of Photoperiod on Major Belle Sweet Corn[a]

	Hours of light		
	10	13	16
Leaves visible at tassel initiation	9.5	9.7	17.0
Days to tassel initiation	26	27	50
Days to pollen shed	66	66	87
Total leaves	19.8	19.2	25.5

[a] Plants were grown in plant growth chambers at the indicated photoperiods until tassel initiation took place and were then transferred to the greenhouse.

CONSUMER ACCEPTANCE of Cotton Fabrics Varying in Laundry and Abrasion Damage

RUTH LEGG GALBRAITH and MARIAN LOUISE BUCH

How well will a fabric perform in actual use? And how well will the consumer accept that performance? These are two of the major unsolved problems confronting the textile and apparel industries.

Laboratory tests of textiles measure just one fabric property at a time. Actual use of a fabric, however, may change a number of properties simultaneously. Moreover, type and rate of wear vary with the consumer and with the type of garment in which the fabric is used.

Even if laboratory tests could be devised to simulate the over-all effects of wear, the actual length of garment use still could not be estimated without knowing how much change a consumer will accept before discarding the garment.

The consumer's acceptance of fabric wear may vary with socio-economic factors such as income and age, and with the use to be made of the garment. A study was therefore devised with these objectives:

1. To determine consumer acceptance of various levels of laundry and abrasion damage in cotton fabrics and the relationship between degree of acceptance and changes in specific fabric properties as determined by laboratory tests.

2. To determine how consumer acceptance of "worn" fabrics was affected by (a) income level, (b) where the garment was to be worn, and (c) availability of original fabric samples as a basis for comparison.

Three fabrics in test

Three cotton broadcloth fabrics with wrinkle-resistant finishes and essentially the same construction were used in the study. Fabric A was light blue; fabric B, navy blue; and fabric C, eggshell. These colors were chosen because they are popular, and we wanted to minimize the effect of color on a fabric's acceptability.

"Wear" or damage to the fabrics was produced in the laboratory by laundering and by tumble-abrasion in an Accelerotor at 3,000 r.p.m., using a 250 grit liner. The laundering was done (after fabrics were separated by color) in a top-loading automatic washer using a 7-pound load, 135° F. wash water, 1 cup of heavy-duty, controlled-suds detergent, and a warm-water (105° F.) rinse. After being tumble-dried for 40 minutes, the fabrics were ironed with a steam and spray iron at a cotton setting.

Five levels of damage were chosen on the basis of appearance of the fabric specimens. Level I included the undamaged original fabrics. The other levels were obtained by 20 washes plus these treatments: level II, 1 minute of abrasion; III, 3 minutes of abrasion; IV, 5 minutes of abrasion; V, 5 minutes of abrasion plus another 20 washes.

Changes in weight, thickness, stiffness (bending length), wrinkle recovery, breaking strength and elongation, and color (total reflectance and blueness to yellowness) were determined with standard test methods.

Consumers interviewed

Consumer acceptance of the fabrics was studied in two areas of a Chicago suburb. One area was predominantly middle-income ($6,000 to $9,999); the other, moderately high-income ($10,000 to $19,999). Thirty homes from each area were randomly selected from a township map. Several alternates were also chosen in case interviewees were not available in any of the first 60 homes.

The 60 women were asked to rate the fabrics' acceptability for use in a dress in two different situations: (a) shopping in a department store in summer without a wrap, and (b) wearing at home. Ratings were made on a four-point scale ranging from 4 — highly acceptable, to 1 — unacceptable. The women were also asked to explain their ratings.

The fabrics were rated twice — first in a random presentation, then in an ordered presentation. For the random presentation, samples were mounted and presented singly, with no two specimens of the same color being shown in succession. Three replicate specimens for each damage level for each fabric (45 specimens in all) were shown.

For the ordered presentation, five specimens of each fabric (one from each level of damage) were mounted on a cardboard and arranged according to ascending damage levels.

The women could feel the fabrics as well as look at them, but were given no more than one minute to form a judgment for each specimen.

Consumer responses for both the acceptability of the fabric specimens for each type of wear and the reasons for the ranking were tallied. Chi square tests for independence of populations were used to determine the effects of level of damage, income, place of wear, and type of presentation (random or ordered) on the acceptability rating distributions.

How fabrics were affected

Weight, stiffness (bending length), and breaking strength of the fabrics decreased progressively as the damage level was increased from I to IV (Table 1). Adding 20 washes to the level IV test procedure (level V) did not cause further changes.

Deterioration of stiffness and strength was much greater in the warp than in the filling direction. A broadcloth fabric contains a large number of relatively small warp yarns

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vhich rise to the fabric surface and ire therefore the first set of yarns to ibsorb abrasive damage. Filling yarns ire larger and less numerous than varp yarns, and do not rise as far out of the fabric plane.

Increases in fabric thickness Table 1) were caused by teasing out of fiber ends, which gave the fabric a ery slight napping effect. This nap- ing might increase the tactile feel- ng of softness in a subjective evalu- tion of the fabrics.

As damage level increased from I o V, all three fabrics became pro- gressively lighter in color (R_d values or total reflectance increased), with abrics A (light blue) and C (egg- hell) showing the greatest fading Table 2). Fabric B became increas- ngly more blue (b value became more negative) and fabric C became less ellow (b value less positive) as dam- ge level was increased.

Consumers' reaction

When fabrics were presented at andom, consumer acceptance de- reased rapidly as laundry and abra- ion damage increased (Table 3). This decrease was even more strik- ng with the ordered presentation.

Although income level of the re- pondents had little effect on the ac- eptability of the specimens at dam- ge levels II and III, there was an nteraction between income and ac- eptable place of wear at damage evels I, IV, and V. Significantly nore of the high-income group than of the moderate-income group did not consider the original fabrics good nough to wear while shopping. In ontrast, more of the moderate-in- ome group than of the high-income group considered the original fabrics "too good" for wear at home. This lifference became highly significant n the ordered presentation, with 34 "too good" responses in the moder- te-income group as compared with 9 in the high-income group. An ad- litional reason given for rejecting he eggshell fabric was that it would how soil too easily for home wear.

Most of the women in both groups ejected the specimens in damage evels IV and V for shopping. But more of the high-income women than of the moderate-income women re- jected the specimens for home wear.

The reasons that the women gave most often for decreased fabric ac- ceptability were changes in color, body, and crispness. The levels at which comments about these fabric properties became significant were compared with changes in the lab- oratory test data. It was learned that these consumers could detect differences in color of three to four units in reflectance and two units in the "b" values. They strongly ob- jected to changes of eight-ten units in reflectance or four to six units in "b" values. The adverse comments on loss of crispness indicated that the respondents could detect differences of only 0.3 to 0.4 centimeter in warp bending lengths. Losses in fabric weight of 0.5 to 0.8 ounce per square yard caused a significant number of adverse comments about loss of body.

From these results it can be con- cluded that the respondents could discern differences in weight, stiff- ness, and color caused by laundry and abrasion. These differences had highly significant effects on the ac- ceptability ratings of the fabrics. In- come level, situation in which a gar- ment was to be worn, and type of presentation had much less signifi- cant effects on acceptability ratings.

Table 1. — Effects of Laundry and Abrasion on Physical Properties of Fabrics (Average Values for Three Fabrics)

Damage level	Weight	Thickness	Bending length		Breaking strength	
			Warp	Filling	Warp	Filling
	oz./sq. yd.	*in.*	*cm.*	*cm.*	*lb./in.*	*lb./in.*
I	3.6	0.010	1.9	1.3	67	26
II	3.4	0.014	1.7	1.2	53	29
III	3.1	0.015	1.6	1.2	28	28
IV	2.8	0.016	1.5	1.3	18	28
V	2.8	0.016	1.5	1.3	19	29

Table 2. — Effects of Abrasion and Laundry on Color, as Shown by Tristimulus Color Measurements

Fabric	Levels of damage				
	I	II	III	IV	V
Color scale R_d (Hunter units)					
A	20.0	23.3	26.5	29.1	29.9
B	2.3	2.7	3.4	4.0	4.9
C	58.1	62.1	63.4	63.6	66.8
Color scale b (Hunter units)					
A	−32.3	−33.6	−32.8	−31.6	−32.0
B	−5.3	−7.1	−8.4	−9.1	−10.1
C	+9.8	+5.2	+4.8	+4.3	+3.4

Table 3. — Average Number of Responses Specifying Acceptance of Three Fabrics at Five Damage Levels; Specimens Presented in Random Order

Damage level	Income level	Acceptance level for shopping[a]				Acceptance level for home wear[a]			
		4	3	2	1	4	3	2	1
I	Moderate	46	25	11	8	35	15	17	23
	High	38	22	10	20	24	21	18	27
II	Moderate	24	25	23	18	26	26	20	18
	High	17	18	20	35	19	15	21	35
III	Moderate	9	12	27	42	13	21	27	29
	High	8	17	21	44	12	17	23	38
IV	Moderate	8	7	18	57	11	17	26	36
	High	6	6	16	62	9	6	23	53
V	Moderate	10	8	12	60	11	14	27	38
	High	8	8	16	58	9	11	21	49

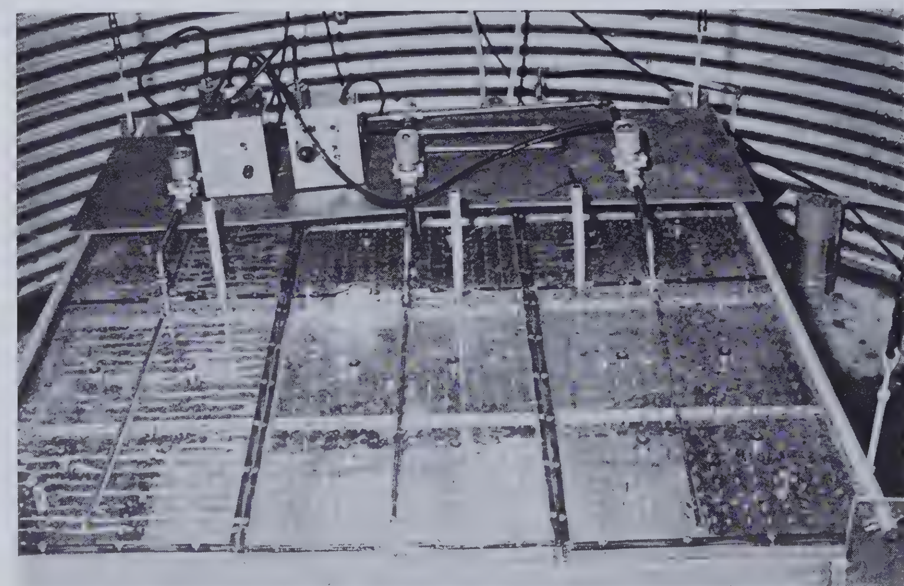
[a] Ratings were: 4, highly acceptable; 3, moderately acceptable; 2, barely acceptable; and 1, unacceptable. Responses for each income level at each damage level should total 90 — 3 fabrics times 30 respondents. Variability within the 3 replicate specimens for each fabric has been averaged.

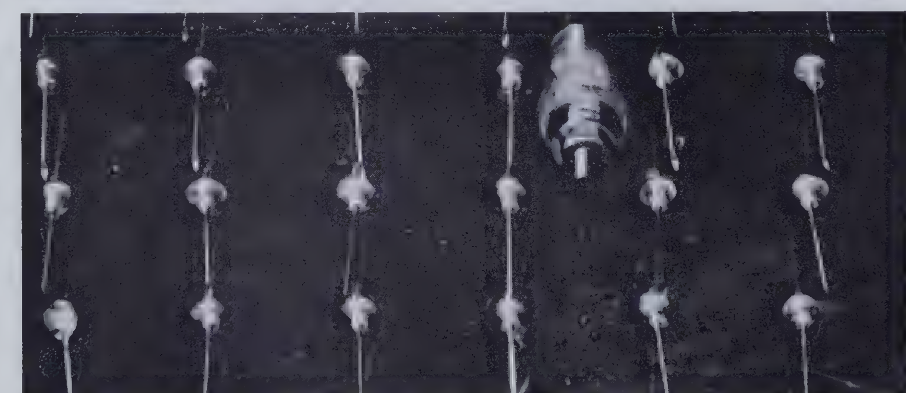
Drop tower and work area. (Fig. 1)

BETTER EROSION CONTROL Is Ultimate Aim of Studies With Artificial Rainfall

GARY D. BUBENZER and J. KENT MITCHELL

It's raining most of the time inside a 32-foot drop tower on the University of Illinois farms. The tower, shown in Figure 1, was constructed for studies of the erosion process that are being made in the Department of Agricultural Engineering.





Upper picture shows overall top view of rainfall modules with solonoid controls to each module. Lower picture shows the underside of one of the modules, with the hypodermic needles that are used to form raindrops. (Fig. 2)

The seriousness of water erosion in Illinois was pointed up in *Illinois Soil and Water Conservation Needs Inventory,* published by the Cooperative Extension Service for the Soil and Water Conservation Needs Committee in 1962. According to that report, erosion was the dominant conservation problem on about 10,538,000 acres of Illinois farmland. Better erosion control practices were needed on 7,316,000 of these acres.

Although such practices as contouring, strip cropping, and terracing are common in many parts of Illinois, there is a growing need for improving these practices and finding new methods of erosion control to meet the requirements of the highly mechanized agriculture of today. The entire erosion process must be better understood if erosion is to be reduced to an acceptable level.

Effects of raindrop features

The Agricultural Engineering Department is conducting research on two aspects of the erosion process. The first concerns the effects of physical features of the raindrops on erosion.

The importance of the energy of the falling raindrop in detaching soils has long been recognized. For erosion to take place, energy is needed to detach and transport the soil, and this energy is largely supplied by the falling raindrops. To study the erosion process, it is necessary not only to reproduce the energy levels of natural rainfall, but also to deter-

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ıine the effects of drop size and npact velocity as components of inetic energy. Specifically, we need ɔ know how the raindrop's size, ɔeed of impact, and kinetic energy ffect the detachment of soil parcles from the soil mass.

Experiments designed to study this uestion are now under way in the rop tower. It is 32 feet tall, so that mulated raindrops falling from the op of the tower have a maximum rop of about 30 feet before hitting ɔil samples at the bottom of the ɔwer. This distance is great enough ɔr drops to closely approach their erminal velocity before striking the ɔil.

Three plexiglas modules, each 48 ıches long and 16 inches wide, are uspended within the tower (Fig. 2). 'ieces of hypodermic needle tubing xtend from the bottom of the modles on a 1-inch grid spacing. Water owing through the tubing forms mulated raindrops at the tips of ıe tubing.

Changing the size of the tubing aries the size of the drops. Intensity f application is controlled by a flow egulator which is relatively independent of the line pressure. Impact elocity of the drops is determined y the height from which they fall. Iodules can be lowered to reduce ıe fall height and hence the energy level. For most drops, however, maximum kinetic energy is obtained by raising the modules to the height necessary for the drop to reach terminal velocity.

Effects of varying drop size and impact velocity, while holding energy at a constant level, are being studied on four Illinois soils. The soils range in physical characteristics from loamy sand to silty clay.

Soil samples are placed in splash cups 3 inches in diameter and the rate of splash is observed from each cup with each combination of drop mass and impact velocity. To provide a random distribution of all drops at all fall heights, the samples are slowly turned on the oscillating table shown in Figure 3.

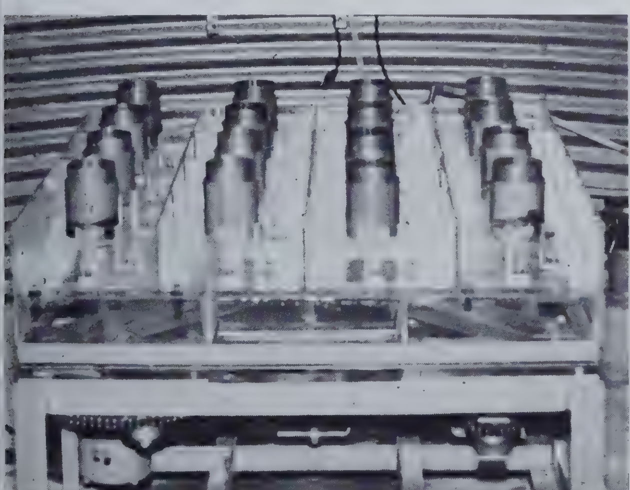
From the information obtained, we will evaluate the importance of carefully simulating natural rainfall and of simulating drop mass and impact velocity as well as total energy. With these evaluations, it may be possible to suggest ways of improving conservation research under simulated rainfall.

Rainfall-runoff phenomena

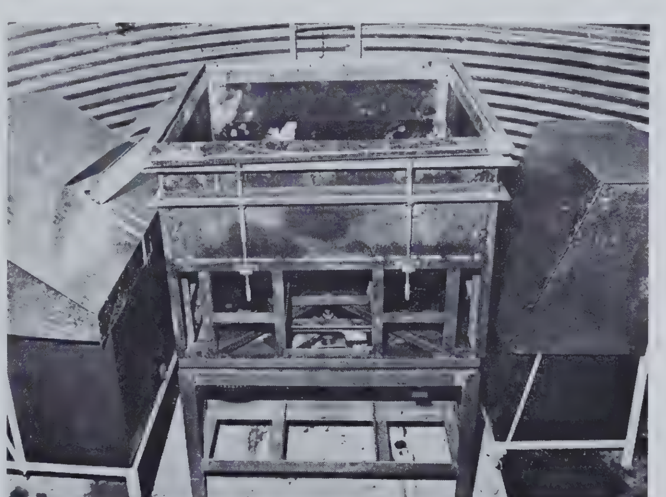
The second investigation under way concerns a portion of the rainfall-runoff phenomena. Surface depressions decrease runoff by retaining some of the rainfall on the soil surface. This water is later added to the subsurface water supply through infiltration. To describe the rainfall-runoff sequence more accurately, we need to know more about the extent of surface-depression storage and its change with rainfall intensity and duration. Some representative values for surface-depression storage under various soil-management conditions are available. Little is known, however, about changes in storage with changes in amount and duration of rainfall.

This subject is being investigated in the same drop tower used for the first investigation. Controlled rainfall is provided by the raindrop modules already described. Rainfall intensity and duration are varied for each test. The tank shown in Figure 4 holds a soil sample which is a foot deep and 36 inches square. Associated equipment measures rainfall, runoff, and infiltration. A soil-profile measuring device is used to "map" the soil surface on a 1-inch grid before and after each application of rainfall.

The information obtained from this investigation will be useful in evaluating the relative importance of surface depression storage in the rainfall-runoff sequence and in refining runoff-estimation procedures for further research studies.



oil sample holders for soil detachment studies are placed on ı oscillating table. Splash guards have been removed from ıe table to give a better view of the holders. (Fig. 3)



Soil tank and associated equipment which are being used to study rainfall-runoff phenomona. The tank holds a soil sample 1 foot deep and 3 feet square. (Fig. 4)

Attractive development of space is the basic concern of the landscape architect.

United Efforts Are Needed To Beautify a Community

WILLIAM R. NELSON, JR.

OUR SOCIETY has never been more exposed to ugliness, pollution, and physical blight than it is right now. Yet chances are that little will be done about these problems until people become so aware of the shortcomings in their own communities that they determine to take action.

Most efforts to create public awareness of the problems and to improve the environment are grouped under the nebulous terms of "community beautification" or "natural beauty." Such terms are somewhat unsatisfactory, however, for beauty is necessarily subjective.

Landscape architects, planners, and architects particularly object to the term beautification. It implies a "cosmetic" approach which is largely a matter of treating the effect rather than tackling the causes of the problems. Yet no one has introduced a better term, perhaps because beautification is a concept that the public can come to grips with. It places responsibility for environmental improvement where it belongs — in the hands of the people.

Regardless of how a program of environmental improvement is labeled, it must be concerned with the causes of the erosion or destruction of beauty in urban and rural areas. This does not, however, justify disdain for relatively small beautification efforts. Planting flowers along Main Street may not revolutionize the environment, but it may make people aware that the surroundings can be improved. Flowers can lead to trees, and trees to parks, and parks to planned and controlled growth. There is thus room for the smaller "cosmetic" type effort as long as it is not the only goal of beautification.

Actually, a beautification program must be considered at a number of different scales — from large-scale plans to individual buildings, the adjacent open space, and even waste containers, benches, and signs.

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Initiating a program

To initiate a successful beautification program, a community must rely on individuals and groups who have expressed an interest in the quality of the environment. The first order of business for this core leadership is to develop a program designed to dispel public apathy toward disorder and ugliness and to point out the potential rewards for a sense of order and beauty. Opportunities exist along the urban-rural fringe, at the entryways to the town, along the strip commercial developments bordering the arterial approaches, and around schools, churches, parks, and squares.

A number of techniques can be used to get a program started. Which ones will be most effective depend on the region and the community. The Cooperative Extension staff can help to choose the most appropriate methods for a given situation.

One successful approach has been a local beautification conference. It may be either invitational or open to the public. Its purpose is to focus attention on local problems of ugliness, poor design, and lost opportunities. The program should be designed for greatest impact through the use of colored slides and speakers who will discuss the problems in practical terms and propose reasonable, attainable solutions. Most important, the conference should give people an opportunity to air their ideas. This process may be painful, but it is essential for achieving support and involvement.

Public information program

An effective public information program is essential to obtain community awareness of the problems and later, community involvement for solving them. The conference just described provides a natural opportunity for publicity on radio and television and in newspapers.

To be most successful, a public information program must have a continuous follow-up long after the conference. News stories, ideas, interviews, and photographs should flow to the news media. It is also important to keep in touch with the staffs of these media. The better they understand the program, the better they will support it.

Initially the public information program should not try to offer solutions for the problems. The effort should be focused on alerting people to the fact that problems exist. This is the time to establish

ne proper perspective about the :ope of a beautification program. It not, for example, primarily con- ɜrned with billboards, junkyards, or litter of trash. Billboards can be re- ɪoved, junkyards can be screened, nd trash can be picked up.

The major concern of the beauti- cation program is the growth of the uter fringes of the community. Too ften this growth consists of ill-con- ɜived, poorly designed service sta- ons, shopping centers, drive-ins, ɔads, and housing tracts that con- ict with the natural landscape. 'his careless building forms a type of tter that cannot be picked up.

Another concern is for important isual amenities — trees, shrubs, owers, street furniture — skillfully ɔmbined to create attractive space ɪat will help to establish a pleasant :ale relationship between people ɪd the buildings around them.

ɔng-range plans necessary

The total beautification effort must ɜ broader than most past programs ave been. It is not enough to gain :cognition of the problems or to ɪitiate one or two projects. The ɜautification program must be or- ɪnized with long-range plans to gain community-wide commitment for lving the problems.

This commitment may take several fferent forms, depending on the cal situation. One alternative is for ɪe local governing body to adopt a solution which officially commits ɪe community to a program of im- oving the environment. The pro- am would then be a function of e local government.

Another alternative is to organize citizens' committee, not officially a ɪrt of the local government, but rongly supported by government of- :ials, civic organizations, and the ɪblic. This alternative requires ɪreful thought and skillful planning that the organization will have lequate public support and provi- ɔns for continuous operation.

With the commitment comes the tablishment of an official beautifi- tion organization. The membership ould include representatives from each taxing authority, from business, and from industry, as well as key individuals or citizens' groups that represent the public. With this representation the organization could work to overcome the lack of coordination and the fragmentation that exist in the expenditure of public funds by different taxing authorities or districts.

This organization might include any of the following functions *if enough professional guidance is available*: Conduct an inventory of the community — its setting, physical layout, and people — to determine what should be done to preserve and enhance the landscape. Serve as an advisory or review agency that would evaluate new governmental developments to avoid mediocre designs that will mar rather than enhance the environment. Serve as a catalytic agent for stimulating significant and quality work by private enterprise. Function as a watchdog committee to alert the citizens to the merits or threats of proposed highways, dams, lakes, housing proposals, and other construction, and to urge public participation in hearings related to such projects.

In addition, the organization must, at the outset, determine its role in "action" programs. Two types of organization are functioning successfully in the state. One is primarily educational, with its action program limited to stimulating government and private organizations to accomplish beautification projects. The other type of organization goes further, planning and executing projects of its own.

For the second type of organization, the first job is to list all the projects that are needed. Next, priorities must be established to determine which jobs should be tackled first. Otherwise, too many jobs may be undertaken at once, dissipating manpower, spreading resources too thin, and producing no significant results. The membership becomes discouraged and public confidence is undermined.

Both types of action program must insist on appropriate professional assistance in all work. Significant environmental changes cannot be do-it-yourself projects. This means that the beautification organization must know the responsibilities and limitations of each design profession.

Creating a successful environment requires collaboration among architects, landscape architects, and planners. It is fallacious to assume that an architect can perform landscape architectural services, or that a landscape architect can design a building. It is also erroneous to think of landscape architecture merely in terms of trees, shrubs, and flowers spotted throughout a development. Rather, the basic concern of the landscape architect is land and its uses, and the development of all space outside of buildings for people who will work, play, and travel on the land.

The specialists and citizens' groups are mutually dependent on one another. The two must work together. Jointly their efforts will be effective, but separately they will never achieve their full potential.

Awards program

Any type of beautification organization should consider an awards program for good design. Such a program helps to reinforce public and private efforts toward community improvement. This technique is a positive approach that costs little but accomplishes much, both in good will and in a chain reaction. More and more people will become aware of design opportunities in all areas of the community — residential neighborhoods, industrial and business sites, roads, parking lots. For beauty is contagious.

Extension philosophy

This article represents in part the philosophy and approach of the Cooperative Extension program in landscape extension. The approach is intended to help people identify their problems and determine the best methods of solving them. Basically it attempts to broaden the concept of beautification and to harness private initiative to produce imaginative ideas for action.

Lack of Money Need Not Keep Students From Going to College

KARL E. GARDNER

Few people realize how many forms of assistance are available to young people who wish to attend institutions such as the University of Illinois. Considering these numerous aids, I think it can be rather safely stated that there is no reason why a young man or young woman should feel that he cannot afford to attend college.

Forms of aid

Following are just a few of the many kinds of financial assistance that are now available:

Low tuition. One of the principal forms of educational assistance offered by the University of Illinois is the low tuition cost for state residents. At present the annual tuition charge is $170, plus a hospital-medical-surgical fee and a service fee. Although tuition will be raised to $246 next year, it is still much below the fees of $1,000 to $2,000 (or more) charged by private institutions. When we compare these charges, we can more adequately realize the magnificent effort that this state is making to help its citizens get a college education.

Tuition waivers. Free tuition may be provided under 24 different kinds of waivers. These include waivers for children of war veterans and for students in teacher education; at least one county scholarship waiver for each county (more in counties with a population above 100,000); General Assembly tuition waivers; and county waivers in agriculture and home economics (one each per county). For students in the agricultural curricula alone, tuition waivers had a total value of about $53,000 last year.

The county agricultural and home economics waivers are granted, regardless of financial need, to the student who scores the highest grade on the ACT (American College Testing) examination, which all students applying for admission to the University are required to take. The student must, of course, be accepted by the College of Agriculture to take advantage of the tuition waiver.

For most other types of aid, parents are asked to submit a confidential statement of their assets and income. The College Scholarship Service then determines what the parents should be able to provide and what is needed in the line of a grant, scholarship, or loan.

Cash scholarships. A number of business firms, banks, and individual donors have provided funds for cash scholarships. Last year the scholarships for students in agricultural curricula, excluding home economics, amounted to about $60,000. These scholarships are usually given on the basis of academic excellence as well as financial need.

Educational opportunity grants. The federal government has provided a large fund of money for educational opportunity grants to be used by students who can demonstrate actual financial need. These grants have a maximum allowance of $800 and must be matched by other scholarships or loans.

Emergency and long-term loans. Emergency loans amounting to $100 are usually available for students already in the University. In addition, funds for long-term loans are available through the University, the National Defense Education Act, the Illinois General Assembly program, and other sources. Payment on the interest and principal is usually deferred until the student leaves college.

Students can also usually obtain loans from their local banks.

G.I. Bill. Returning war veterans are provided allowances for schooling in an amount related directly to the length of military service.

Employment. There are usually a number of opportunities for employment on and off the campus. It is usually best, however, for the new student not to work his first semester.

Unused scholarships

As already mentioned, one agricultural scholarship and one home economics scholarship are provided in each county and can cover tuition for four years if a student's academic record is satisfactory. We should have in the neighborhood of 102 of these scholarships in each category in each of the four college years. This would be a maximum total of 408 agricultural scholarships and 408 home economics scholarships in operation at all times, although one would expect some attrition of these scholarships over the years because of poor grades or withdrawal from the college for a number of reasons.

Actually only 172 agricultural scholarships and 86 home economics scholarships were in use the first semester of last year. This is regrettable because it represents lost opportunities. In some counties, either no application was made for the tuition waivers or else nobody made the minimum required grade on the ACT examination.

More information

Further information on financial aids is available from the Office of Student Financial Aid, University of Illinois, Urbana, Illinois 61801.

Karl E. Gardner is Associate Dean and Director of Resident Instruction, College of Agriculture.

ORIGINS OF CROPS SOUTH OF THE SAHARA IN AFRICA

J. M. J. DE WET

The world food problem has given increasing importance to programs of international agriculture at the College of Agriculture. This article represents one aspect of these programs — collection of plant species with the ultimate aim of increasing food production at home and abroad. Other facets of international agriculture will be presented in later issues of Illinois Research.

MAN HAS BEEN in Africa for a long time. Evidence is accumulating ıat this may be his birthplace. Yet ery little is known about early man ›uth of the Sahara. What plants did e domesticate? Where were they rst grown? Where, in subsaharan ,frica, did man first till the soil? .nswers are still being sought to these nd many other questions.

Present knowledge suggests that 'heat and barley were already grown ı the Near East almost 10,000 years go and that the practice of cereal ıltivation was introduced into Egypt etween 3000 and 4000 B.C. But any ɔncrete evidence of such early farm-ıg communities in subsaharan Africa completely lacking. Tools associ-'ted with known cultures of this time eriod (pottery, digging sticks, sick-·blades, grindstones, and even hoe-ke implements) could have been sed just as well by food gatherers ; by food producers.

The best available evidence sug-ɛsts that wheat and barley were in-oduced to the Ethopian Highlands, irectly from the Near East or via gypt, perhaps as many as 5,000 ɛars ago. Two important crops, teff *Eragrostis tef*) and ensete (*Ensete dulis*), are endemic to Ethiopia, but ere probably domesticated later.

From the Ethiopian Highlands the ıowledge of plant domestication ›read to the adjacent East Central .vannah and eventually to the low-nd forests and savannah of West frica. Wheat and barley, however, 'e not well adapted for cultivation ı the African savannah, and the ›read of agriculture became possible only after native African plants were domesticated.

Ethnologists often argue that there must have been an earlier and independent center of plant domestication in West Africa. Fonio (*Digitaria exilis*), African rice (*Oryza glaberrima*), and groundnut (*Kerstingiella geocarpa*) are confined to the West African savannah, while the oil palm (*Elaeis guineense*), guinea yams (*Dioscorea spp.*) and the kafir potato (*Coleus dazo*) are grown only in the tropical forest of West Africa. However, archaeological evidence for such a center of original domestication is completely lacking.

The Central African savannah has no endemic crops, and those from West Africa and Ethiopia never became widely established outside their centers of origin. This may be due to an essential absence of early contact between the Bantu and their neighbors to the north. It may also be possible that abundant game and wild millets provided the Bantu with so ample a diet that agriculture was not necessary. When agriculture did reach East Central Africa, *Sorghum bicolor* and the millets *Pennisetum americanum* and *Eleusine corocana* became the staples.

These crops are also widely grown in West Africa, but the varieties grown in West Africa, Ethiopia, and East Central Africa all differ from one another. Furthermore, sorghum is accompanied by distinctly different weeds in each of these geographic regions, suggesting that this crop may have been domesticated independently from different wild races in Ethiopia, West Africa, and East Central Africa.

The widely cultivated cow pea (*Vigna sinensis*), watermelon (*Citrullus vulgaris*), and calabash (*Laegenaria siceraria*) are closely allied to wild and weedy races that extend beyond the boundaries of Africa, and consequently may not be native African domesticates. Numerous other crops are known to have been introduced. The Malayans brought Asian cultigens to Africa, and the Portuguese introduced crops from the New World. Native tubers are being replaced by taro (*Colocassia antiquorum*) and yams (*Dioscorea spp.*), introduced from Asia; and by cassava (*Manihot utilissima*) and sweet potato (*Ipomoea batata*) from the New World. Asiatic rice (*Oryza sativa*) and American maize are planted in preference to native grains.

African markets are full of minor crops that are used as drugs, condiments, or vegetables. Several of these are only half domesticated, and often not easy to distinguish from their wild ancestors. Others are strictly domesticates and probably introduced.

Crops are more or less genetically isolated from their wild relatives. However, they occasionally cross to produce crop-weed-wild complexes. A tremendous amount of genetic variability is preserved in these hybrids. Although this gene pool is often overlooked by plant breeders, it may become important in future plant-breeding projects.

The present population explosion does not seem to be slowing down significantly. For the present at least, the world's millions will have to be fed with the harvests from crop plants. To insure an abundant food supply in the future, we must develop means to preserve all crop plant variability, and techniques to utilize this variability in breeding projects.

M. J. de Wet is Professor of Plant Cyto-ınetics, Crop Evolution Laboratory. The work ported here is supported in part by grants ɔm the National Science Foundation.

FARM BUSINESS TRENDS

THE YEAR 1968 may be considered to have been a good one for most Illinois farmers, though some suffered from low yields of crops.

On the favorable side we find a record-high yield per acre of soybeans, and good prices for hogs, cattle, and milk. By contrast, yields of corn and wheat were disappointing on many farms.

Soybean yields were surprisingly good, even where corn did not do well. The state average yield was 31.5 bushels per acre. This was a new record, 0.5 bushel more than in 1967, and 3.5 bushels more than the 5-year 1962-1966 average.

The Illinois corn crop started off well, but many central and southern areas suffered from heavy rains and cold weather after planting. Some areas then had severe drouth in August and also suffered from high temperatures about mid-month. Some farmers also reported severe damage from insects and disease.

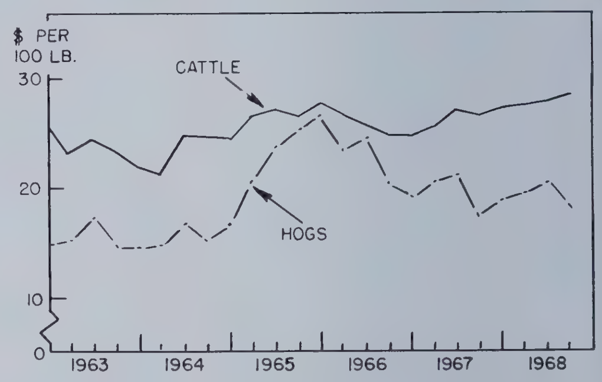
Many farmers in central and southern Illinois reported average yields down 10 to 30 bushels from 1967, but the northeastern part of the state had record-high yields. The Cooperative (state-federal) Crop Reporting Service has estimated the average yield at 89 bushels per acre. While this is 11 bushels less than in 1967, it is 4 bushels over the 5-year 1962-1966 average. The quality of the crop was very good, in contrast with the 1967 crop, which did not dry properly. The 1968 crop may therefore bring more dollars per acre than the 1967 crop.

The average wheat yield for 1968 was estimated at 36 bushels per acre, which is 3 bushels less than for 1967, and 1 bushel less than the 5-year average. The oat yield was estimated at 66 bushels, which is 6 bushels more than the previous record set in 1966.

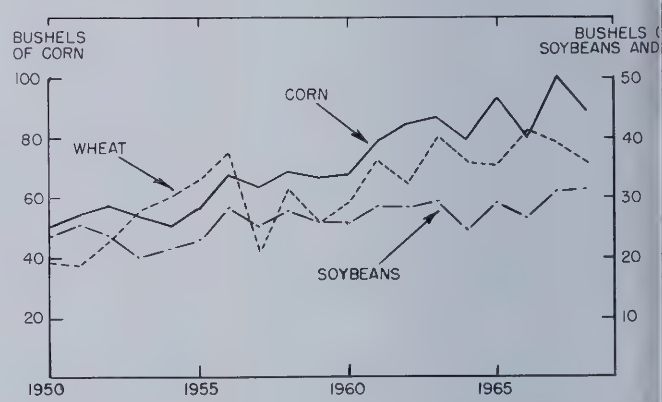
Hog prices were good in 1968, as prices for barrows and gilts generally ranged from $18 to $20 per hundred pounds. Hogs at these prices made good profits, since corn prices were around $1.05 or lower most of the time. Prices of hogs have been at profitable levels for about four years, an unusually long period.

Prices of beef cattle trended upward in 1967 and 1968. Most Choice steers brought $27 to $28 per hundred pounds. The yearly average price was the best since 1962, and there was very little change during the year, except for the slight upward trend.

Profits on dairy farms have increased in recent years. Prices received for milk by Illinois farmers were 33 percent higher in 1968 than in 1955-1959, while average prices received for all products were up only 7 percent. As a result, dairymen are earning incomes comparable to those of most other farmers. — *L. H. Simerl*



Prices of choice steers at Chicago and of barrows and gilts at eight markets, quarterly, 1963-1968.



Average yields per acre of corn, soybeans, and wheat, Illinois, 1950-1968.

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

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ARE COLLEGE STUDENTS DIFFERENT TODAY?

PARENTS and other citizens often ask, "What is the matter wit college students — are they different today?" In answering th question, it is imperative that we not be too hasty.

We have gone from a period when students and the gener public were perhaps "under-concerned" about the problems whic plague modern society, to a period of intense concern becaus problems of civil rights, poverty, and other unsatisfactory cond tions are not speedily remediable.

A very small percentage of college students, estimated at a frac tion of one percent, believe that neither the universities nor th government has come to grip with these problems and that ou institutions need to be cleaned off the slate. These are the activis agitators, who have been described by Professor S. L. Halleck, c the University of Wisconsin, as "articulate, irreverent, humorles and relentless in their contempt for what they view as adu hypocrisy."

A second, larger group, including some very bright students, a also unhappy about the problems and feel that efforts to find rem edies should be rapidly intensified. These students, however, wa to work within the framework of present institutions.

The rest of the students — probably more than 90 percent c the total — are very similar to students of previous generation They know they have a job to do — to prepare themselves for career and for living and enjoying life in an increasingly compl world. This group includes almost all students in agriculture, eng neering, and other technology-oriented fields.

Dissident students should be "heard out" and their suggestio seriously considered. On the other hand, activities which interfe with the operation of a university or a government will not be pe mitted or treated lightly. The punitive powers of society must, the same time, be used with restraint and with a view to helping t individuals involved. Punishment for punishment's sake by an a gravated society is not productive.

Today's college students are our own sons and daughters a are, in large measure, what we and our society have made then They do need guidance at this critical period of their developmen Most of them are listening — at least with one ear. It is imperati that our University say things worth hearing. — *Karl E. Gardne Associate Dean and Director of Resident Instruction*

Price Expectations and 1969 Acreages of Corn and Soybeans in Illinois

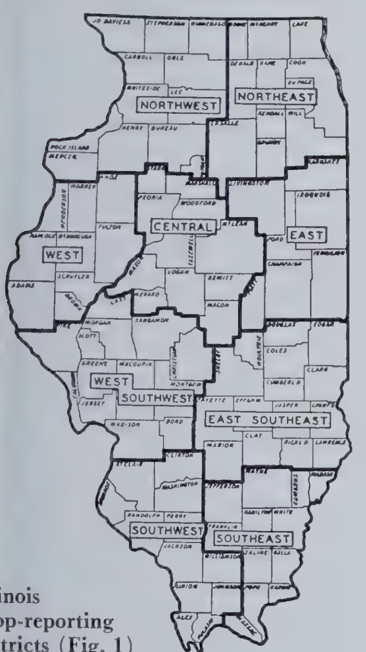
EARL SWANSON

YEAR-TO-YEAR shifts in crop acreages result from a complex set of ctors. Among them are farmers' ıdgments as to which crops will give aximum returns above variable osts. These judgments are based on xpectations regarding prices, costs, ıd yields for each alternative crop.

A number of other factors, howver, modify year-to-year shifts in creage. These include reluctance to disrupt established crop patterns, differences among crops in seasonal labor requirements, government programs, and feed requirements for an established livestock system.

In this article, we will focus on the influence that expected prices for corn may have on the 1969 acreages of corn and soybeans. The procedures used in this study take into account both the desire of farmers to maximize returns above variable costs and their reluctance to make bold changes in cropping patterns.

To indicate what yields farmers might reasonably expect in 1969, the 1966-1968 average yields of the six major Illinois crops are presented in Table 1. The yields are given for each of the nine crop-reporting districts shown in Figure 1.



linois
op-reporting
stricts (Fig. 1)

Table 1. — Average Yields per Acre, Illinois, 1966-1968[a]

District	Corn	Soybeans	Oats	Wheat	Hay	Pasture
		bushels			tons	days[b]
NW. . .	97	32	64	37	3.08	154
NE. . . .	90	29	64	39	2.85	143
W.	92	32	57	34	2.46	123
Cen. . .	94	35	59	38	2.69	135
E.	92	31	56	41	2.26	113
W.SW.	92	33	51	38	2.53	127
E.SE. . .	85	28	53	41	2.08	104
SW. . .	71	26	44	38	2.32	116
SE. . . .	73	24	38	37	1.79	90
State. .	90	30	61	39	2.58	129

[a] 1968 yields are preliminary estimates reported in CROPS, Illinois Cooperative Crop Reporting Services, October 10 and November 12, 1968.
[b] Estimated from district hay yields on plowland pasture with 1 ton of hay equal to 50 pasture days.

Estimated acre returns above variable costs are presented in Table 2. Except for soybeans, the figures are based on prices received by farmers from April through September, 1968. The soybean price was based on the 1969 support price. Account was taken of price differences among crop-reporting districts. State average prices were as follows:

Corn	$ 1.02 per bushel
Soybeans.	2.30 per bushel
Oats.	0.64 per bushel
Wheat.	1.21 per bushel
Hay	21.70 per ton
Pasture	0.16 per pasture day

Table 2. — Returns per Acre Above Variable Costs[a]

District	Corn	Soybeans	Oats	Wheat	Hay	Plowland pasture
rthwest.	$61.56	$46.90	$23.44	$26.80	$44.75	$24.64
rtheast.	56.30	41.76	23.44	29.20	35.16	22.88
est.	56.24	46.90	22.15	24.20	30.02	19.68
ntral.	58.92	55.30	22.66	28.18	44.23	21.60
st.	56.24	46.66	21.60	31.62	26.36	18.08
est Southwest.	56.24	50.32	19.87	28.94	29.53	20.32
t Southeast.	50.15	39.62	21.01	29.57	19.74	16.64
thwest.	43.29	35.08	17.20	27.42	30.01	18.56
theast.	45.80	29.86	13.60	25.32	16.32	14.40
te.	55.40	43.90	23.13	29.20	33.25	20.64

[a] Based on average yields (Table 1) and, except for soybeans, average district prices received by farmers il through September, 1968. Soybean price was set at 1969 support level. Variable costs for grains include l, repairs, seed, fertilizer, and labor at $2.00 per hour. Variable hay costs include harvesting costs and a rge for fertility removed. See R. A. Hinton, *Farm Management Manual*, AE-4178, 2d. revision, Dept. of Ag. n., Univ. of Ill., Jan. 1968.

As already mentioned, certain stabilizing factors modify the size of year-to-year shifts in acreage. The extent to which farmers will adjust acreages to changing conditions may be gauged by the size of past acreage adjustments.

Year-to-year adjustments in the acreages of the six major crops, 1946 to 1966, are presented in Table 3. Adjustments are expressed as percentage changes from acreages in the preceding year. Average sizes of increases and decreases are given for each crop in each district, together with the numbers of years in which increases or decreases occurred. In the northwest district, for example, corn acreage was increased in 13 of the 20 years, with the average increase being 3.7 percent. The other 7 years, corn acreage was decreased by an average of 3.6 percent.

In general, the major crops are not likely to show a pronounced year-to-year shift in acreage. Some substantial shifts that did occur in individual years were obscured by the

Earl Swanson is Professor of Farm Management and Production Economics.

Table 3. — Acreage Adjustments of Principal Illinois Crops Expressed as Average Percentage Increases or Decreases From Preceding Year, 1946-1966[a]

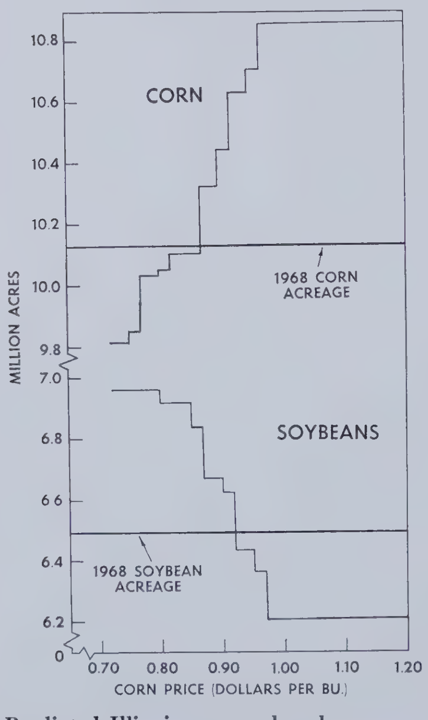
District	Corn		Soybeans		Oats		Wheat		Hay		Plowland pasture	
	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease
NW....	3.7 (13)[b]	−3.6 (7)	14.7 (14)	−11.7 (6)	7.0 (5)	−5.9 (15)	13.3 (9)	−16.2 (8)	4.9 (6)	−3.2 (14)	1.8 (5)	−4.9 (15
NE.....	4.1 (11)	−4.0 (9)	13.8 (13)	−8.5 (7)	6.2 (5)	−8.5 (15)	20.7 (11)	−13.3 (8)	3.5 (6)	−5.5 (14)	6.2 (4)	−8.1 (16
W......	6.7 (12)	−5.4 (8)	7.9 (13)	−9.2 (7)	3.9 (5)	−10.2 (14)	17.9 (11)	−13.1 (9)	17.0 (6)	−8.7 (14)	5.4 (10)	−6.2 (10
Cen.....	6.7 (12)	−6.4 (8)	11.2 (11)	−7.4 (9)	4.9 (9)	−11.1 (12)	13.4 (11)	−13.4 (8)	10.9 (5)	−7.4 (15)	4.1 (7)	−9.1 (12
E.......	5.2 (13)	−7.9 (6)	8.1 (12)	−4.7 (8)	10.2 (5)	−11.6 (15)	25.8 (12)	−15.7 (8)	14.4 (4)	−7.8 (16)	7.5 (5)	−10.9 (15
W.SW..	6.4 (13)	−7.5 (7)	5.2 (13)	−5.0 (7)	26.2 (5)	−17.0 (15)	10.6 (11)	−10.3 (9)	14.7 (4)	−6.4 (16)	6.0 (7)	−8.3 (13
E. SE....	7.7 (14)	−11.5 (6)	4.8 (11)	−2.3 (9)	21.4 (6)	−18.5 (14)	14.8 (12)	−10.2 (8)	6.7 (3)	−6.7 (17)	3.3 (4)	−8.5 (16
SW.....	8.3 (11)	−8.0 (9)	9.0 (16)	−4.6 (4)	24.8 (5)	−18.9 (13)	7.9 (8)	−8.2 (12)	4.6 (8)	−5.6 (11)	7.4 (7)	−9.3 (15
SE......	8.7 (13)	−11.3 (7)	8.6 (16)	−6.5 (4)	37.3 (6)	−26.2 (12)	10.2 (13)	−16.1 (7)	5.8 (7)	−7.7 (13)	7.5 (5)	−7.4 (15
State...	5.6 (12)	−5.4 (8)	6.1 (13)	−3.8 (6)	16.1 (3)	−8.8 (17)	9.9 (12)	−11.3 (8)	6.9 (4)	−4.8 (16)	1.9 (4)	−5.8 (15

[a] Data are based on planted acres of the grain crops, harvested acres of hay, and the land reported in plowland pasture irrespective of its use.
[b] Numbers in parentheses indicate the number of year-to-year increases or decreases entering the average percentage change presented. When the years in whi increases occur are added to the years in which decreases occur, the sum is not always 20 because sometimes there was no acreage change from one year to the ne

average figures. These averages, however, indicate the probable limits within which short-run adjustments can be expected to occur.

Expected acreages

The limits of change indicated in Table 3 were considered in formulating Figure 2, which shows probable 1969 soybean and corn acreages at varying corn prices. It is assumed that returns from major crops other than corn will remain the same as in Table 2.



Predicted Illinois corn and soybean acreages with various expected prices for corn. **(Fig. 2)**

With the expected corn price of \$1.02, we can expect 1969 acreages of a little over 10.8 million for corn and a little over 6.2 million for soybeans. A comparison of these acreages with estimates based on a soybean price of \$2.55 indicates a shift of about 0.2 million acres from soybeans to corn as a result of the lower price support for soybeans.

Figure 2 covers a much broader range in corn prices than is expected in 1969. These prices were included to point out the competitive position of corn with respect to other crops. The "stair steps" in the lines indicate points at which corn displaces another crop.

As we increase the price of corn above 70 cents a bushel, the first step occurs at about 75 cents. This represents a shift in acres in the west crop reporting district from hay to corn. The next step, at about 77 cents, represents a shift from wheat to corn in the southeast district. Each successive step indicates a similar shift to corn from some other crop.

The break-even corn prices in Table 4 indicate the sequence in which crops are displaced by corn as the price of corn increases. The break-even prices in Table 4 do not correspond exactly with those in Figure 2 because district prices differ from the state average price.

From April through September, 1968, the state average corn price was \$1.02 and the soybean price, \$2.55. At these prices corn has a higher return above variable costs

Table 4. — Corn Prices at Whic Returns Above Variable Costs Equ Those for Five Other Crops[a]

District	Soybeans	Oats	Wheat	Hay	Pasture
	Necessary corn price, \$ per bu.				
NW.....	0.87	0.63	0.66	0.85	0.6
NE.......	0.87	0.66	0.73	0.80	0.6
W.......	0.91	0.64	0.66	0.72	0.61
Cen......	0.98	0.63	0.69	0.86	0.6
E........	0.92	0.63	0.74	0.68	0.5
W. SW...	0.94	0.61	0.71	0.72	0.6
E. SE.....	0.89	0.67	0.77	0.65	0.6
SW......	0.92	0.66	0.81	0.84	0.6
SE.......	0.84	0.60	0.76	0.64	0.61
State....	0.89	0.66	0.73	0.77	0.6

[a] See Table 2. Other crops except soybeans assumed to sell at average price April-Septemb 1968. Soybean price is based on 1969 support lev

than soybeans in all districts exce the central and west southwest. Wi a soybean support price of \$2.3 corn has a higher return than so beans in all districts (Table 2).

In Figure 2 the competition b tween corn and soybeans begins at corn price of 80 cents. A substanti number of soybean acres are tran ferred to corn at a corn price about 87 cents a bushel and aga at 92 cents. The upper limits adjustments from 1968 acreages, indicated by the actual year-to-ye shifts between 1946 and 1966, a reached at a corn price of 97 cen a bushel. In the corn price ran in which corn and soybeans compe (80 to 97 cents per bushel), a percent increase in the expect corn price results in an increase 0.4 percent in corn acreage.

ANIMAL POISONS FROM MOLDY CORN

M. P. STEINBERG and A. I. NELSON

-OR MANY YEARS poisons produced by microorganisms have been im- plicated as the cause of illness and ometimes death in livestock. The cientific community did not become larmed until 1960, however, when 00,000 English turkeys and ducks ied after their feed had been con- aminated by a strain of the mold *lspergillus flavus.*

The strain of *A. flavus* known as *]. flavus* Link ex Fries is especially kely to be harmful, although other rains of *A. flavus,* as well as of ther mold species, are also known to roduce toxins.

A. flavus Link ex Fries produces our toxic metabolites called afla- oxins which are very damaging to e liver. In experiments with farm nd laboratory animals, extremely nall doses caused liver lesions lead- ng to acute toxemia, and even naller doses fed over an extended eriod of time resulted in liver ancer. No known cases of aflatoxin oisoning have been reported in man.

Present processing methods cannot econtaminate feeds that contain flatoxins. These substances are able to heat even at high tempera- ures, to acid, and to most chemicals xcept strong chlorine solutions. A ontaminated feed thus cannot be sed for livestock and it also becomes serious disposal problem, represent- ng an economic loss from every andpoint. Prevention of toxin for- ation is the only answer.

According to previous research, latoxin production parallels growth the mold. Therefore, to avoid xin production we must prevent old growth.

Mold spores (seeds) of *A. flavus* ay be found floating in the air most everywhere, especially on or ear the farm. Wherever these spores find the proper environment, they germinate and grow rapidly to form a thick mat of mycelia on the surface of their food supply, much as mold grows on bread. More important, some mold mycelia penetrate beneath the surface, where they will most likely excrete toxin.

The proper environment for mold growth includes, of course, a source of food — corn and wheat serve admirably. Moisture is of equal importance. Corn above 15.5 percent in moisture content is very susceptible to mold growth when it is stored at temperatures above 55° F. The rate of mold growth increases rapidly as moisture content and storage temperature are increased. Therefore, if corn must be stored with more than 15.5 percent moisture, the danger of aflatoxin development is very real.

Objective of study

A recent study in the Department of Food Science had the objective of working out techniques and procedures to decrease the danger of aflatoxin development in feeds.

Previous microbiological investigations had shown that an atmosphere high in carbon dioxide inhibits mold growth. It was therefore decided to investigate the effects of carbon dioxide and temperature on growth of *A. flavus* and toxin production in a high-moisture medium.

A. flavus NRRL 2999, a known toxin-producing strain, was supplied for this work by Dr. Hesseltine of the Northern Regional Research Laboratory of the U.S. Department of Agriculture in Peoria. This strain was inoculated on two substrates.

First experiments

The first experiments were done on a basal liquid medium commonly used by microbiologists for growth studies. Because this medium is easy to manipulate in the laboratory, much information on mold growth and toxin production could be obtained in a relatively short time. This information was very useful in designing later experiments with shelled corn.

The basal medium was incubated for 2 to 3½ weeks at room temperature (78°-95° F.), and 60°, 54°, 50°, 45°, and 34° F. The incubation was done both in air and in controlled atmosphere (CA) containing 10 percent carbon dioxide (CO_2) and only 1.8 percent oxygen (O_2). Ordinary air contains 0.03 percent CO_2 and 21 percent O_2.

At all temperatures, CA delayed growth and decreased the maximum level of toxin. The critical temperature appeared to be 60° F. At this temperature, growth and toxin in air reached a maximum while in CA the mold showed only slight growth and produced little toxin. At temperatures below 60° F., growth and toxin were inhibited both in air and in CA. However, the CA enhanced the inhibitory effects of low temperature.

It was concluded that toxin production paralleled growth; where growth was severely inhibited, toxin was negligible or even absent.

Experiments with corn

Cracked corn was the growth medium used for the second phase of the study. The kernels were broken to make them more susceptible to mold growth and were inoculated with *A. flavus.* Different portions of this corn were hydrated to moisture contents of 16.6, 18.8, 23.6, and 31.2 percent (dry basis) in equilibrium with relative humidities of 70, 80, 90, and 100 percent respectively at room temperature. (In the following paragraphs, reference to a particular relative humidity always means that the corn was at the corresponding moisture content.) The corn samples were stored under air

(Please turn to page 6.)

P. Steinberg is Professor of Food Engi- ering, and A. I. Nelson is Professor of Food ocessing, both in the Department of Food ience.

ILLINOIS SOILS REMAIN HIGH IN NUTRIENTS

According to 1968 Plant and Soil Analyses

W. M. WALKER, T. R. PECK, S. R. ALDRICH, and W. R. OSCHWALD

The fertility level of both corn and soybean fields was just as high in 1968 as in 1967, according to a survey being conducted by the Department of Agronomy and agricultural extension advisers.

The purpose of the survey, which was begun in 1967, is to measure the nutrient status of Illinois soils by analyzing plant and soil samples from selected corn and soybean fields in every section of the state.

Results for 1967, covering 19 counties, were reported in the Summer, 1968, issue of Illinois Research. An additional 39 counties were surveyed in 1968 (see map on page 7).

Plant samples were collected at two growth stages — early and midseason. Whole plant samples were collected in the early growth period, when corn was 12 to 18 inches tall, and soybeans were 6 to 10 inches. The midseason period was defined as tasseling time for corn and full height for soybeans. At this stage the leaf opposite the ear was obtained from corn plants and topmost fully developed leaves were obtained from soybean plants.

The samples were analyzed for nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), boron (B), copper (Cu), iron (Fe), manganese (Mn), zinc (Zn), and sodium (Na). Aluminum and silicon were also determined, but were considered indicators of sample contamination rather than nutrition factors.

Soil samples were taken at three depths (0-6 inches, 12-18 inches, and 24-30 inches) and tested for pH, available phosphorus, and exchangeable potassium.

Mean levels of various chemical elements in corn and soybeans in 1968 are shown in Table 1. The levels of most elements were remarkably similar to those observed in 1967. Sodium shows the most year-to-year variability, but it is not essential for either corn or soybean production.

Generally, the means in Table 1 indicate that the nutrient status of sampled fields is adequate for high yields. Thus, the results of this survey do not bear out the suggestion of some observers that the reduction in

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Animal poisons . . . (Concluded)

and CA at room temperature (78°-95° F.), 60° F., and 45° F.

In air at room temperature, the mold grew prolifically at relative humidities of 100 percent and 90 percent, only sparsely at 80 percent relative humidity, and not at all at 70 percent. Controlled atmosphere, however, greatly restricted mold growth at room temperature and humidities of 100 and 90 percent. Below 90 percent relative humidity, no growth was visible in CA.

At 60° F. in air, growth took place only at 100 percent relative humidity. In CA, growth was dormant even at 100 percent relative humidity, with no growth being observed at lower humidities. At 45° F., growth was inhibited in both air and CA at all humidities.

These results clearly showed that *A. flavus* would grow only within a narrow range of temperatures and moisture. A subsequent experiment with corn was therefore limited to 100 percent relative humidity at room temperature and at 60° F.

In this experiment, growth and toxin development were variable in controlled atmosphere at 60° F. Good growth and toxin production sometimes occurred after long lag periods; other times the mold remained in a lag growth stage throughout the incubation period of 513 hours.

Some comparisons

At room temperature both in CA and in air, toxin was produced much faster on corn than on the basal medium. The rate of toxin production was also greater on corn in CA at 60° F. These results are due to two things: corn is a better substrate than basal medium, and the average room temperatures during incubation were slightly higher for the corn experiments.

On both mediums, growth and toxin development were slower in CA than in air at room temperature and at 60° F. The inhibitory effect of CA, using growth in air as a standard, was greater at 60° F. than at room temperature.

Golding (1949) showed that controlled atmospheres containing more than 10 percent carbon dioxide significantly inhibited growth of *A. flavus*. He also found that 60° F. was a critical temperature for the organism in both air and in CA. Slightly lower temperatures limited growth substantially, but temperatures slightly above 60° F. allowed a fair amount of growth. With rising temperatures, growth increased until the range of 90°-110° F. was reached, after which growth declined.

Future work should include incubation of *A. flavus* in controlled atmosphere containing more than 10 percent carbon dioxide. Temperatures for the study should range from about 60° F. to about 110° F. Also a more detailed study should be made of the effect of moisture content within the range covered here.

ɔrn yields from 1967 to 1968 was ue to a lowering of soil fertility.

Average soil test values for the ıree soil depths are shown in Table Frequency distributions of soil st values for surface samples in ɔrn and soybean fields are shown . Table 3. A soil pH level of 6.1-5 is usually considered desirable ır corn or soybeans, and for both ops this was the range with the ghest frequency. A soil P level of l-50 and a soil K level of 241-300 e acceptable maintenance levels for ɔth corn and soybeans.

ounties where plant and soil samples ere taken in 1967 and 1968.

ɔble 1. — Mean Levels of Various Chemical Elements in Corn and Soybeans, 1968

ıemical lement	Corn Early	Corn Mid-season	Soybeans Early	Soybeans Mid-season
pct.	3.60	3.13	4.42	4.71
pct.	0.34	0.29	0.33	0.31
pct.	3.52	1.97	2.10	1.64
ı, pct.	0.48	0.60	1.45	1.17
g, pct.	0.30	0.30	0.58	0.42
p.p.m.	10	9	40	51
ı, p.p.m.	13	12	16	16
, p.p.m.	300	179	426	170
ı, p.p.m.	66	66	83	70
, p.p.m.	38	33	56	52
ı, p.p.m.	304	291	496	371

Tests below the desirable pH and fertility levels indicate a need for additional applications of agricultural limestone and fertilizer P and K.

Table 4 presents some simple correlations between selected factors. For corn, soil test values correlated with plant composition much better in the early sampling period than at midseason. As the corn's rooting system develops and becomes less dependent upon surface soil K, the correlation for this element might be expected to decrease, but the decrease by midseason was even greater than expected. Leaf Zn and soil P were postively correlated at midseason, as were leaf B and soil K.

In both corn and soybeans, leaf Zn and Mn were negatively correlated with soil pH. This association has been observed in various states, although it has been reported oftener for corn than soybeans. Percent Mg was negatively correlated with percent K in both crops. This illustrates a potential problem with these nutrients in that a high level of one often results in a low level of the other.

With a few exceptions, the correlations in Table 4 are similar to those observed in past studies. Continuing research with plant analysis will help provide more precise interpretation in the future.

Table 2. — Mean Soil Test Values for Corn and Soybeans, 1968

Soil depth, inches	Corn pH	Corn P_1	Corn K	Soybeans pH	Soybeans P_1	Soybeans K
		lb./A.			lb./A.	
0- 6	6.21	61	344	6.35	53	348
12-18	5.86	23	266	5.93	21	282
24-30	5.96	20	283	6.05	18	306

W. M. Walker is Assistant Professor of Biometry and Data Processing, T. R. Peck is Assistant Professor of Chemistry; S. R. Aldrich is Professor of Soil Fertility Extension; and W. R. Oschwald is Associate Professor of Soil Classification, all in the Department of Agronomy.

Table 3. — Frequency Distribution of Surface (0"-6") Soil Test Values, 1968

pH range	No. of samples Corn	No. of samples Soybeans	P_1 test range (lb./A.)	No. of samples Corn	No. of samples Soybeans	K test range (lb./A.)	No. of samples Corn	No. of samples Soybeans
≤4.5	1	0	≤10	10	15	≤120	9	21
4.6–5.0	9	4	11– 20	50	52	121–180	71	52
5.0–5.5	71	30	21– 30	67	60	181–240	98	61
5.6–6.0	107	72	31– 40	90	57	241–300	103	56
6.1–6.5	159	85	41– 50	63	33	301–500	146	86
6.6–7.0	99	73	51–100	140	64	501–800	41	26
7.1–7.5	36	47	101–200	60	29	801–1100	13	5
>7.5	10	6	>200	12	7	>1100	11	10

Table 4. — Selected Simple Correlations Between Plant and Surface-Soil Nutrients and Between Nutrients in the Plant, Corn and Soybeans, 1968

Factors correlated	Corn correlations Early sample	Corn correlations Midseason sample	Soybean correlations Early sample	Soybean correlations Midseason sample
Pct. P with soil P	0.24**	−0.06	0.48**	0.23**
Pct. K with soil K	0.43**	0.02	0.51**	0.32**
p.p.m. Zn with soil P	0.14**	0.08†	0.06	0.01
p.p.m. Zn with soil pH	−0.25**	−0.25**	−0.19**	−0.16**
p.p.m. B with soil K	0.07	0.16**	−0.08	0.00
p.p.m. B with soil pH	−0.17**	0.08†	−0.14*	0.00
p.p.m. Mn with soil pH	−0.23**	−0.24**	−0.23**	−0.24**
Pct. Mg with soil K	−0.34**	−0.32**	−0.30**	−0.22**
Pct. Mg with pct. K	−0.48**	−0.27**	−0.54**	−0.42**
Pct. P with p.p.m. Zn	0.12**	−0.01	0.05	0.06

† Odds are more than 9 to 1 against a chance correlation this large.
* Odds are more than 19 to 1 against a chance correlation this large.
** Odds are more than 99 to 1 against a chance correlation this large.

Care Is Needed To Avoid Ammonia Injury to Corn

Stands may be reduced by shallow, heavy applications of NH_3 just before planting

G. W. COLLIVER and L. F. WELCH

MANY ILLINOIS FARMERS apply nitrogen for corn in the spring before planting. Much of it is in the form of anhydrous ammonia (NH_3).

With NH_3 being readily available and low in cost, and with increased economic pressures forcing farmers to aim for higher corn yields, rates of NH_3 application have gone up rapidly in the past few years. Earlier planting is also being encouraged for higher yields, shortening the time interval between NH_3 application and planting.

The result of these trends is that many rather heavy applications of NH_3 are being made very close to planting time. If applications are too shallow and the corn is planted right on top of the NH_3 band, the NH_3 may prove toxic to the seed or roots. Injury to the germinating seed or the roots of young plants may reduce the stand of corn. There have been scattered reports from various parts of the state that preplant applications of NH_3 may have caused stand reductions.

Research with preplant NH_3

Some research with preplant NH_3 for corn has been conducted on the Agronomy South Farm at Urbana. The objective was to study germination and early growth of corn as affected by NH_3 applied at different rates, depths, and times before planting.

Anhydrous ammonia was injected into field plots of a Flanagan silt loam at rates of 100, 200, 300, and 400 pounds of nitrogen per acre. It was applied at depths of 4, 7, and 10 inches, and at 0, 2, and 4 weeks before planting corn. Rates of NH_3 were based on 30-inch spacings of applicator knives.

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Corn was planted 2 inches deep directly on top of and parallel to each NH_3 injection band. Check plots were planted to corn without NH_3 applications.

Periodic stand counts were made to determine if NH_3 delayed or inhibited germination. During the early growth, plant heights were measured to check for stunting. Visual observations were made for injury symptoms, and some plants were dug up to observe effects of NH_3 on establishment of the root system.

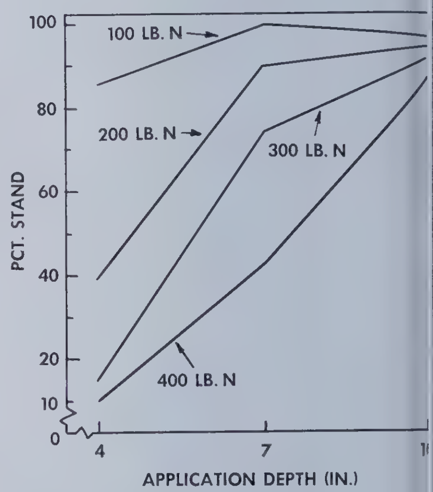
Some of the treatment combinations resulted in toxic amounts of NH_3 in the area of the germinating seeds or in the rooting zone of the seedlings. When this occurred, either germination was delayed or inhibited, or root development was restricted. These effects led to stand reduction and stunted growth of the young plants.

Reduced stand

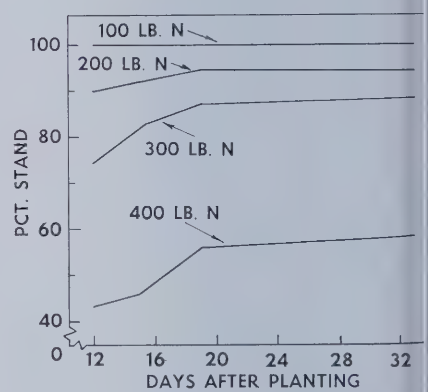
By 12 days after planting, seeds on the check plots were fully germinated. The percent germination on the NH_3-treated plots, as compared with the check plots, varied with depth and rate of NH_3 applications. Figure 1 shows the percent stands on plots where NH_3 was applied the same day the corn was planted.

Where 100 pounds of nitrogen per acre was applied 4 inches deep, the stand was only 86 percent of that on the check plots. If this same amount was applied at least 7 inches deep, however, the stand increased to nearly 100 percent.

Applying 200 pounds of nitrogen 4 inches deep reduced the stand to



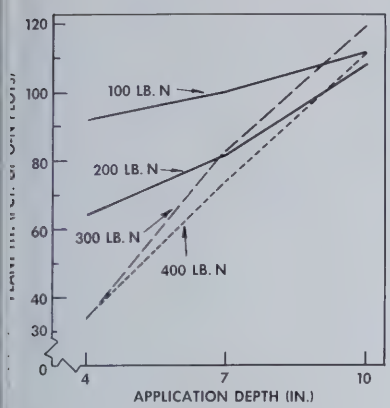
Effect of rate and depth of NH_3, applied the same day as planting, on corn stand 12 days after planting. Plots receiving no NH_3 equal 100 percent. (Fig. 1)



Effect of rate of NH_3, applied 7 inches deep on the same day as planting, on time required for germination. (Fig. 2)

39 percent. But the stand increased to 90 percent with an application depth of 7 inches, and 94 percent with a depth of 10 inches.

At the 300- and 400-pound rates stands were greatly reduced when applications were either 4 inches or 7 inches deep. Applied 10 inches deep, however, the 300-pound rate



]fect of rate and depth of NH_3, applied ie same day as planting, on corn plant]ight 6 weeks after emergence. O-N]ots received no NH_3. (Fig. 3)

ve a stand of 92 percent; and the 0-pound rate, 87 percent.

]elayed germination

Part of the reduction in stand own in Figure 1 was due to a delay i germination on plots receiving avy applications of NH_3. Figure 2 ows the effect of application rate a the time required for germination. he data are for 7-inch applications ade immediately ahead of planting.

With 100 pounds of nitrogen, the and was 100 percent 12 days after anting. The 200-pound rate, how- er, not only reduced the final stand it also delayed germination. The and continued to increase until 19 ys after planting, a week longer an at the 100-pound rate. Slight icreases in stand even after 19 days re observed on plots receiving the 0- and 400-pound applications.

;unted plant growth

That some treatment combinations inted the young plants can be seen i Figure 3. This graph shows how plication rate and depth affected ant height 6 weeks after emergence. leight is represented as a percentage plant height on the plots receiving nitrogen. The fact that some of ie plant heights are over 100 per- nt is due to a growth response to trogen.

Where 100 pounds of nitrogen as applied 4 inches deep, plant ight was 92 percent of that on the check plots. When the same amount was applied 7 or 10 inches deep, plant height was 100 percent or more. Rates of 200 pounds and greater, applied both 4 and 7 inches deep, caused even more severe stunting than the 100-pound rate applied 4 inches deep. But plant growth was increased when these rates were applied 10 inches deep.

Root restriction

When the plants reached about the 4- or 5-leaf stage of growth, a purple coloration was observed on some of the leaves. This symptom, typical of phosphorus deficiency, was most prevalent where the higher rates of nitrogen had been applied at the shallower depths.

A sample of the discolored plants was found to contain 0.20 percent phosphorus, as compared with 0.36 percent for normal-appearing plants. Large amounts of NH_3 in the rooting zone probably restricted root development so much that the seedlings could not absorb enough phosphorus for normal growth. The purple coloration disappeared in a few weeks as the plants were able to establish a more extensive root system.

A corn seedling with roots damaged by NH_3 is shown in Figure 4. The darkened, constricted roots in the lower center portion of the picture had a burned appearance. It was observed that seedling roots would not grow into an area of large amounts of NH_3. The plants did, however, show a remarkable ability to adapt to the situation by simply growing around the NH_3 band to establish a root system.

The toxic effects were somewhat reduced by applying NH_3 at least 2 weeks before planting. If the NH_3 was applied deep enough, however, the time interval was of little importance. Applying NH_3 under less than ideal conditions merely to establish a time interval can be a poor practice.

Farm situations

In these studies all the corn was planted directly above the NH_3 injection band. Under farming conditions, corn would by chance be planted directly over the band only one-sixth of the time, so the expected injury would be only one-sixth as severe as in our study. For example, the 90-percent stand associated with 200 pounds of nitrogen applied 7 inches deep (Fig. 1) would be about 98 percent if planting were random.

Corn seedling with roots damaged by NH_3. The darkened, constricted roots in the lower center part of the picture looked as if they had been burned. (Fig. 4)

Anemia Prevention in Young Pigs

B. G. HARMON

Two methods of administering iron orally are recommended as the result of Illinois studies

ANEMIA, or low hemoglobin, has been a problem in pigs ever since swine producers "improved" management by farrowing swine in buildings with wooden or concrete floors. Pigs in this environment are deprived of soil, the natural source of the iron which is necessary to maintain hemoglobin.

Until about 15 years ago, numerous laborsome, often ineffective methods of preventing anemia were tried. Then, in the middle 1950's, English workers developed injectable iron compounds which prevent anemia effectively, and which have been widely accepted by swine producers. A single injection will provide enough iron to sustain hemoglobin until pigs are consuming iron-adequate dry diets.

The development of injectable iron has generated renewed interest in methods of preventing anemia in pigs. Particular attention has been given to finding new and efficient methods of administering iron orally.

At least three different procedures for oral administration have been studied in the Department of Animal Science. Two of these methods are recommended. They are effective and inexpensive, require a minimum of labor, and eliminate the muscle damage that sometimes occurs with injections.

Supplementing sows' diet

The first of the Illinois studies showing the value of oral iron for young pigs was actually designed to test the value of ferrous fumarate in the sow's diet.

According to previous research, feeding extra amounts of iron to the sow would not significantly increase iron in the pig at birth or in the milk during lactation. One research team, however, had reported that hemoglobin was increased in young pigs whose dams had received iron in the form of ferrous fumarate. This team had speculated that the source of iron could influence the iron content of the milk.

In the Illinois study, ferrous fumarate was added to the sows' diet at the rate of 900 milligrams per pound. This did not increase the concentration of iron in the milk (Table 1), but hemoglobin values were increased in the nursing pigs. These values were high enough to keep the pigs from being anemic although the values were not as high as those in pigs receiving injections of iron dextran.

Feces from sows fed the high levels of ferrous fumarate were extremely black, indicating the presence of much iron. It was therefore presumed that the pigs nursing these sows obtained their extra iron by playing in the fecal matter. Although feeding ferrous fumarate to the sows prevented anemia in th pigs, this procedure is not recom mended.

Table 1. — Effect of Adding Ferrous Fumarate to Corn-Soybean Meal Diet Fed to Sows During Lactation

Diet of dam	Corn-soybean meal diet		Diet plus Fe fumarate	
Iron in milk at 3 weeks, p.p.m.	1.55		1.47	
Pigs injected with 200 mg. Fe	No	Yes	No	Yes
Av. hemoglobin, gm./100 ml.				
Initial	9.4	9.5	9.5	10.3
3 weeks	5.6	11.6	8.2	12.5
Pct. survival at 8 weeks	72.9	82.8	80.0	86.7
Av. weight at 8 weeks, lb.	17.4	27.9	26.0	26.1

Pigs get enough iron when dry materia containing iron sulfate are placed in pe twice a week. (Fig. 1

Dry iron-containing material

The observation that nursing pi could obtain iron from fecal matt suggested that other material migh be put in the pen to provide th iron they need. A study was ther fore undertaken to determine th value of iron sulfate introduced in the pen in three different forms: (1 mixed with a low-density materi (sphagnum moss), (2) compresse into a pellet of inert materials, (3 mixed with a typical corn-soybea meal lactation diet.

The materials were put on th floor of the pens twice a week. As i the previous study, half of each litt was injected with iron dextra These treatments were compare with a previously used treatment th consisted of spraying the sow's udd with a saturated iron sulfate solutio twice a week.

B. G. Harmon is Associate Professor of Animal Science.

nemia can be prevented by adding sup-
emental iron to the pigs' drinking water
soon as they are born. (Fig. 2)

As shown in Table 2, the iron-
ılfate materials, placed on the floor
vice a week, all prevented anemia.
he pigs were consuming enough
on to support normal hemoglobin.
praying the sow's udder with iron
ılfate, however, did not provide the
gs with the iron needed to main-
in normal hemoglobin values.

According to these results, an ef-
ctive way of preventing anemia in
ırsing pigs, using a minimum of
bor, is to mix iron sulfate with the
ctation diet (10 percent iron sul-
te and 90 percent lactation diet),
nd distribute about 6 ounces of the
ixture on the floor twice a week.

quid materials

In another study, water-soluble
on was dissolved in the pigs' drink-
ıg water. Ferric ammonium citrate
as the form used.

Water fountains were placed in
e farrowing crates at parturition
ig. 2). Alternate litters were given
ater, plus a supplement containing
rric ammonium citrate as well as
tamins and neomycin.

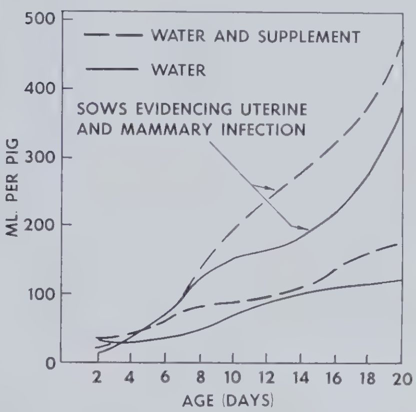
The pigs started drinking water
birth and increased their con-
mption with age (Fig. 3). The
crease in consumption was partic-
arly rapid in pigs that nursed sows
idencing mammary and uterine
fection.

As shown in Table 3, pigs main-

Table 2. — Effect of Oral Sources of Iron Sulfate on Hemoglobin of Pigs[a]

Source of iron sulfate	Solution on sow's udder		Mixed with sphagnum moss		In pellet of inert material		In corn-soybean meal diet[b]	
Pigs injected with 200 mg. Fe	No	Yes	No	Yes	No	Yes	No	Yes
Av. hemoglobin, gm./100 ml.								
7 days	7.3	8.4	8.4	9.0	8.5	8.9	8.2	9.2
14 days	7.4	10.8	10.2	11.7	9.9	11.5	10.2	11.5
21 days	8.4	12.4	11.3	12.4	10.9	12.7	11.9	13.1

[a] 1,134 pigs. [b] 90 percent corn-soybean meal diet; 10 percent iron sulfate.



Baby pigs' daily consumption of water and of water plus supplement. (Fig. 3)

tained normal hemoglobin values when their only source of supplemental iron was the drinking water. This indicates that anemia can be prevented in young pigs by providing iron in the water.

The supplement also increased the rate of gain and the percent survival. These effects may have been due as much to the antibiotic and vitamin additions as to the iron. The increased gain and reduced mortality suggest the need for further work in supplementing milk for young swine.

Biological availability of iron

Prevention of anemia requires that iron must be not only physically available, but also biologically available. As shown in our studies, ferrous sulfate and ferric ammonium citrate can be utilized by pigs.

Until recently, however, ferrous carbonate was the major source of iron in the trace mineral mixtures added to Illinois swine rations. In a study at the University, ferrous carbonate would not support normal hemoglobin levels when added to the

Table 3. — Effect of Oral Iron Source in Drinking Water[a]

Oral treatment	Water only	Ferric ammonium citrate in water	
Pigs injected with 200 mg. Fe	Yes	No	Yes
Av. hemoglobin, gm./100 ml.			
Initial	9.8	9.8	9.7
10 days	11.0	11.5	10.6
21 days	13.2	13.7	12.8
Pct. survival	89	95	98
Av. weight at 21 days, lb.	8.9	9.9	9.7

[a] 383 pigs.

Table 4. — Biological Availability of Different Iron Sources

Source of iron	Basal diet	Ferrous carbonate	Ferrous sulfate
Total iron, p.p.m.	12	58	60
Av. hemoglobin, gm./100 ml.			
15 days	6.8	6.9	10.6
35 days	6.1	6.5	10.9

Table 5. — Biological Availability of Iron in Ferrous Carbonate

Source of iron	Basal diet	Ferrous carbonate		
Total iron, p.p.m.	18	49	95	142
Av. hemoglobin, gm./100 ml.				
Initial	8.2	8.2	8.1	8.2
7 days	5.9	6.2	5.9	5.9
14 days	4.6	5.3	4.7	4.9

ration in amounts to meet the suggested iron requirement (Table 4). Even when more than twice the recommended amount of iron was fed, ferrous carbonate did not support normal hemoglobin (Table 5). Ferrous carbonate is therefore not recommended as a source of iron in trace mineral mixtures.

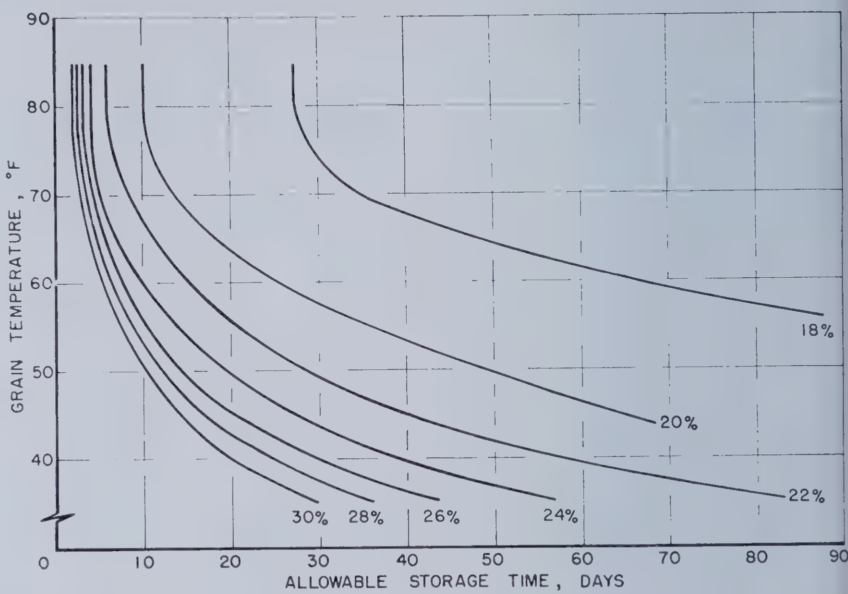
WET GRAIN AERATION for Holding and Drying Shelled Corn

GENE C. SHOVE

EVERY corn producer wants to finish his harvest quickly, without any delays due to undersized handling, storage, or drying facilities. This goal can be achieved if the corn is harvested early and quickly, put into temporary storage at once, and later fed, sold, or dried.

Early harvest, however, usually means wet corn that must be conditioned before it can be sold or stored for extended periods. Heated air drying offers one method of conditioning the corn and controlling microflora activity. Another method is to cool the wet corn by aeration and later dry it at low temperatures.

This method of managing corn works best if moisture content at harvest is no greater than 22 or 23 percent and average daily air temperature is about 40° F. Otherwise the corn is likely to deteriorate before it can be cooled and dried. Very high moistures should be avoided if at all possible. Allowable storage times for wet shelled corn at various temperatures are given in the chart at right.



Allowable storage time for shelled corn at various temperatures and moisture content During this time the grain will lose ½ percent in dry matter, but will still be acceptabl Data are from the U.S. Department of Agriculture Grain Storage Research Laborator Ames, Iowa.

How and why aeration works

As unsaturated air passes through wet corn, the air gives up heat to evaporate moisture from the grain. The dry bulb temperature of the air drops, approaching the wet bulb temperature. The wet bulb temperature will be reached when the air becomes 100 percent saturated, which is likely in corn containing about 22 percent moisture or more. This means that the wet corn will become several degrees cooler than the dry bulb temperature of the entering air.

Table 1 shows the size of the temperature drop from dry bulb to wet bulb measurements for various air conditions. The mean differences between wet bulb and dry bulb temperatures in central Illinois during the four months of the harvest season are: September, 8° F., October, 6° F., November, 4° F., December, 2° F. Since these figures are means, greater differences can be expected in about 50 percent of the years. The temperature reductions in northern Illinois would be about one degree less, on the average, than in central Illinois; and those in southern Illinois, about one degree greater.

The recommended airflow rate for cooling corn at harvest time is ½ c.f.m. per bushel (about 60 pounds of wet corn). At this rate, about 24 hours of fan operation will be required for the corn to reach the wet bulb temperature. Of course, if the fan is operated for only six to eight hours each night, it will take three or four days to complete the cooling.

Winter aeration

After the initial cooling, aeratio at low wintertime temperatures wi reduce moisture content. During th winter of 1967-68, different metho of aeration were tried in four 3,30 bushel steel bins near Monticell Illinois. The bins, which we equipped with perforated floors ar 1-horsepower aeration fans, we filled with 22- to 24-percent moistu corn on December 8.

The fans each pulled about c.f.m. of air per bushel through th corn. A different method of opera ing the fans was used in each bin:

1. Continuously (no control).
2. At an air temperature of 40° and below (thermostat control).
3. Night only (electric-eye co trol) until January 24; then co tinuously.
4. As selected by the owner-oper tor (manual control).

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Table 1. — Size of Drop From Dry Bulb to Wet Bulb Temperatures at Various Air Conditions

Relative humidity, pct.	Dry bulb, temperature, °F. 30	40	50	60
	Wet bulb drop, °F.			
[illegible]	0	0	0	0
[illegible]	1	1¼	1½	1½
[illegible]	2	2½	3	3½
[illegible]	3	3½	4½	5½
[illegible]	4	5	6½	7½
[illegible]	5	6½	8	9½

Table 3. — Effect of Temperature and Humidity on Equilibrium Moisture Content of Shelled Corn

Relative humidity, percent	Moisture content of corn (percent) when air temperature is: 30° F.	40° F.	50° F.
[illegible]5	13	12½	12
[illegible]6	14½	14	13½
[illegible]7	16½	15½	15
[illegible]8	19	18	17
[illegible]9	22½	21½	20½

As shown in Table 2, continuous aration removed the most moisture fm the corn. It was the only mthod that reduced moisture contnt enough to prevent damage to th corn. On the basis of the percnt moisture removed per bushel, th four methods differed very little icost of operation.

Under continuous aeration during priods of high humidity, the damp a is likely to lose some moisture to th corn through which it first passes, fthis corn is below about 22 percnt in moisture content. However, th drier air can then penetrate farthr into the moist corn before bemning saturated. A reduction, hower slight, of the average moisture oall the grain will help prevent deioration in the wettest grain.

Continuous aeration during a day o two of warm weather in winter wl increase grain temperature. This hat energy, however, will help evaporte grain moisture when a drop in a temperature recools the grain.

Other studies besides this one have icated that it's best to operate the a continuously when corn has an initial moisture content of about 20 percent or more. With a lower initial moisture, however, the fan might well be controlled with a humidistat. From December through February, average relative humidity may approach 80 percent, and air this moist will dry corn only to 17 to 19 percent (Table 3). An initial moisture content of about 19 percent can be further reduced only by aerating when relative humidity is below about 80 percent.

In this study, aeration fans were operated as exhaust fans pulling air down through the grain. The final moisture content of the grain can be lowered somewhat more, however, by forcing the air through the grain and taking advantage of the heat dissipated by the fan motor.

The motor heat will usually raise air temperature by 1 to 3 degrees. Within the range of 30°-50° F. in air temperature and of 70-100 percent in relative humidity, a 3-degree increase in dry bulb temperature lowers relative humidity by about 10 percentage points. This much decrease in humidity will reduce the corn's moisture content by about 2 percentage points (Table 3).

Power requirements

Another important consideration in using aeration to reduce corn moisture is the power requirement. An airflow of ½ c.f.m. per bushel is the recommended minimum. Higher airflow may be necessary to insure that corn moisture will be approaching 16 percent by early March. If corn is much wetter at that time, it may have to be moved to prevent deterioration. Power requirement goes up rapidly with an increase in airflow, however, thereby limiting an airflow of much over 1 c.f.m. per bushel to a shallow grain depth.

Table 4 can be used as a guide in selecting the size of aeration fan. For example, if you have an 18-foot diameter bin filled with 3,000 bushels (about a 15-foot depth), a 1-horsepower fan will insure an airflow of ½ c.f.m. per bushel.

Since broken kernels and fines restrict air movement, screening the corn before storage will help achieve efficient aeration and drying.

Table 2. — Results From Four Systems of Aerating 23-Percent Moisture Shelled Corn With an Airflow of ½ c.f.m. per Bushel, December, 1967, to March, 1968

	Aeration system: Continuous	Below 40° F.	Night[a]	As selected by owner
Hr. of operation beginning Dec. 8	2,856	2,417	2,023	2,229
Date unloaded	Apr. 8	Mar. 27	Mar. 25	Mar. 26
Corn removed, lb.	173,860	173,820	181,880	187,850
Corn removed, bu.	3,104.64	3,103.92	3,247.85	3,354.46
Pct. moisture	15.8	18.3	18.8	18.0
Test weight, lb./bu.	56	54	54.5	54
Pct. damage	([b])	5.5	8.5	8.9
Energy cost @ 2¢/kw.-hr.	$57.12	$48.34	$40.46	$44.58
Energy cost, cents/bu.	1.84	1.56	1.25	1.33
Cents per bu. per pct. moisture removed, assuming 23 pct. initial moisture	0.256	0.332	0.298	0.267

[a] Operated continuously after January 24. [b] Within accepted limits (less than 5 percent).

Table 4. — Power Requirements for Aerating Shelled Corn With ½ and 1 c.f.m. per Bushel

Bu. of grain and c.f.m. per bu.	Grain depth, ft. 10	15	20
3,000 bu.	Horsepower		
½ c.f.m.	⅓-½	¾-1	1½-3
1 c.f.m.	1-2	1½-3	3-5
6,000 bu.			
½ c.f.m.	¾-1	1½-2	3-6
1 c.f.m.	2-4	3-6	6-10
10,000 bu.			
½ c.f.m.	1½-2	3-4	5-10
1 c.f.m.	4-6	5-10	10-15
25,000 bu.			
½ c.f.m.	3-4	6-10	15-25
1 c.f.m.	10-15	15-25	25-50
50,000 bu.			
½ c.f.m.	7½-10	15-20	25-50
1 c.f.m.	20-30	25-50	50-75

Mycoplasmal Pneumonia and Other Swine Infections Due to PPLO

Pleuro-pneumonia-like organisms, alone or in combination with other organisms, are responsible for many swine infections, of which mycoplasmal pneumonia is most serious

G. T. WOODS, CAROLYN PILLAI, and H. E. RHOADES

THE VERY SMALL organisms known as *Mycoplasma* or pleuro-pneumonia-like organisms (PPLO) were first reported in Illinois swine in 1955. The report was made by Drs. D. A. Willigan and P. D. Beamer of the College of Veterinary Medicine. Since then, clinical diagnoses of infection by PPLO have been frequently made by veterinarians and diagnostic laboratories.

PPLO are the simplest and smallest known organisms that can be grown in media free of living tissue. Because they lack a cell wall, they are very soft, plastic, and pleomorphic, occurring in shapes which vary from coccoid forms 125 millimicrons in diameter to filaments 400 millimicrons or more long. Colonies of PPLO are very small and transparent and have a characteristic "fried egg" appearance (see illustration on next page).

Perhaps the most serious swine disease due to PPLO in this state is mycoplasmal pneumonia (also known as V.P.P. or enzootic pneumonia). According to present evidence, this type of pneumonia is caused by *Mycoplasma hyopneumonia.* Although V.P.P. may lead to death, it occurs more commonly as a chronic illness, resulting in a general weakening of the animal, a poor rate of gain, and poor feed conversion.

PPLO often occur in combination with other organisms — bacteria, viruses, and parasites (ascarids and lung worms). Mycoplasmal pneumonia, for example, is often complicated by ascarids. Another common example of a mixed infection is that of PPLO and *Haemophilus suis.* Many infections clinically diagnosed as Glasser's disease, which is caused by *Haemophilus suis,* have been diagnosed in the laboratory as being due instead to PPLO.

Laboratory isolations

Laboratory diagnosis of mixed infections in swine is of great value. In 1963 the Urbana Diagnostic Laboratory began procedures to isolate PPLO from specimens that had been sent to the laboratory for diagnosis. The growth medium that is used consists of 1 milliliter of blood agar in a tube overlaid with 2 cubic centimeters of Difco PPLO broth supplemented with 10 percent rabbit serum and 1 percent fresh yeast autolysate. Penicillin, thallium acetate, and cycloheximide are added to inhibit the growth of bacteria and fungi.

Isolations made in 1964-1967 are shown in Table 1. A total of 96 isolations of PPLO was recorded from about 600 diagnostic specimens. The largest numbers of isolations were

Table 1. — Isolation of Mycoplasr Species From Illinois Swine Herds, Urbana Diagnostic Laboratory

Month	Number of isolations				
	1964	1965	1966	1967	To
Jan.	1	1	0	1	3
Feb.	1	0	2	1	4
March	6	2	3	1	12
April	0	3	0	0	3
May	0	1	0	2	3
June	0	2	1	3	6
July	0	4	1	2	7
Aug.	1	4	0	0	5
Sept.	2	3	0	16	2
Oct.	1	4	1	8	14
Nov.	1	2	0	0	3
Dec.	6	0	0	6	1
Total	19	26	8	40	9

made in September, October, I cember, and March. Some isolati were made in every month, howev suggesting that we commonly d with carrier animals.

Some tabulations have been ma of the organisms occurring most co monly with *Mycoplasma* species. 1964, *Pasteurella multocida* was organism most frequently isola with PPLO in lungs infected w mycoplasmal pneumonia. *Haer philus suis* and *Bordetella bronc septica* were second and third in f quency of isolation.

A summary of isolations from v ious tissues during 1967 is given Table 2. The high recovery r from the nasal cavity is significa since PPLO infections are spr through the respiratory system. Ot workers have reported that 60 p

G. T. Woods is Professor of Veterinary Microbiology and Public Health and of Veterinary Research; Carolyn Pillai, Research Assistant in Veterinary Pathology and Hygiene; and H. E. Rhoades, Assistant Professor of Veterinary Pathology and Hygiene. The work was supported by the Illinois Department of Agriculture Swine Disease Research Fund, Illinois Agricultural Experiment Station, and Public Health Service General Research Support.

Tble 2. — Isolation of Mycoplasma Species From Swine Tissues, 1967

Mnth	Lung	Nasal cavity	Joint	Lymph node	Uterus	Total
Jn.					1	1
Fb.					1	1
Mrch . . .						1[a]
Aril. . . .						0
My. . . .	1			1		2
Je. . . .					3	3
Jy. . . .	1	1				2
Ag. . . .						0
Spt. . . .		16				16
Ct. . . .	1	3	2	1	1	8
Nv. . . .						0
D.	1	3	2			6
Tal. . . .	4	23	4	2	6	40

Site not known.

ent of the swine population harbor M. *hyorhinus* in the nasal cavity and tht this organism is found in 50 prcent of pneumonia cases.

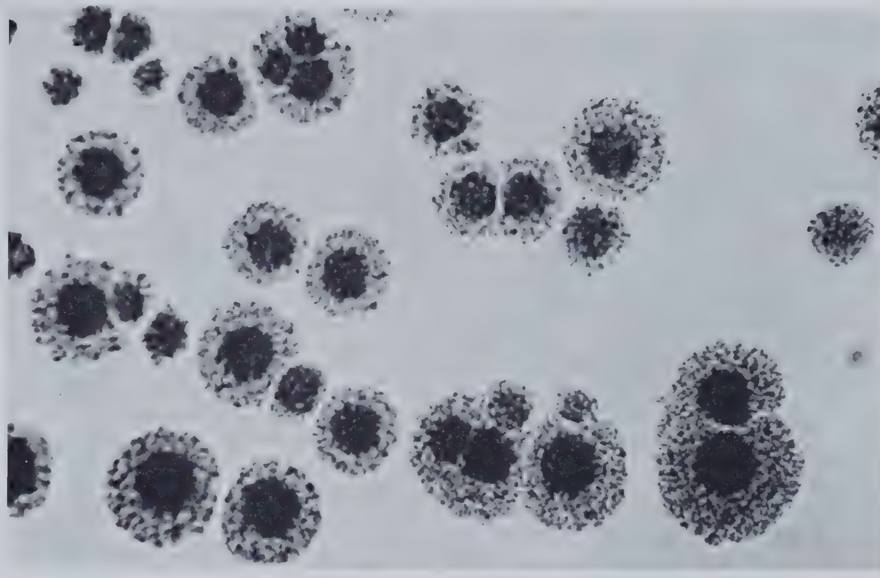
We have not yet evaluated the caracteristics or the pathogenicity, fany, of the uterine isolates, but Dr. Jeph Simon of the Illinois staff is nw conducting research on the sbject.

No PPLO were isolated from semn of nine boars used in artificial iremination. Neither did such sern produce any gross or microsopic evidence of mycoplasmal peumonia when given intranasally t 2-week-old, primary-colostrum-drived pigs.

The significance of the so-called aaline strains of PPLO isolated fm Illinois swine has been only prtially evaluated. Most of the isoions have been *M. granularum* and M *hyorhinus*. These three presumay different strains, together with th uterine isolations, need more sdy before their significance can be elluated in clinical syndromes.

Srologic survey

Of sera collected from 90 boars at a Illinois slaughter plant, 38 gave a psitive agglutination reaction at the 1/5 dilution using a *M. hyorhinus* atigen in a tube agglutination test. These results should be viewed with reerve, however, since the validity o such a test in swine has not been eablished. Serologic findings in kown positive swine have been very eatic.



Colonies of *Mycoplasma hyopneumonia* on agar plate (X100). Photo, Carolyn Pillai.

Table 3. — Prevalence of Mycoplasmal Pneumonia Lesions in Illinois Swine

Date	Source of swine	No. observed	No. herds	No. animals positive	Pct. positive
Oct. 8, 1964.	50-mile radius of Danville	390	11	204	50.2
Jan. 6, 1965.	Charleston buying point	102	Unknown	45	44.1
Winter, 1965.	Ill. commercial herds	46	5	32	70.0
Winter, 1965.	Ill. and nationally accredited SPF herd	10	1	0	0
Totals.	. . . .	548	. . .	281	51.3

V.P.P. in Illinois herds

A survey of some Illinois herds indicated the prevalence of mycoplasmal pneumonia or V.P.P. in the state. Results are summarized in Table 3.

Of special interest is the absence of V.P.P. in the Specific Pathogen Free herd. The techniques of the SPF program eliminated this disease before the actual cause was known.

These techniques include the following steps: (1) Pigs from infected breeding stock are delivered by hysterectomy or Caesarean operation. (2) The pigs are raised in isolation. (3) All other swine on the farm are slaughtered. (4) All equipment is cleaned and disinfected, and the premises are left vacant for at least 60 days. (5) Pigs are not re-exposed to infected swine. (6) Routine farm inspections and slaughter examinations are made to make sure that V.P.P. has not recurred.

Several of the SPF herds in Illinois have maintained this status since 1960. Of the 17 herds accredited during the past five years, only three have been dropped because of mycoplasmal pneumonia.

In the laboratory, pigs have been exposed to laboratory-passed strains of *M. hyopneumonia* obtained from Dr. W. P. Switzer of Ames, Iowa, as well as to two Illinois strains. Although these strains consistently produced microscopic lesions of V.P.P., they did not cause any typical gross lesions. Repeated preparations of laboratory cultures may reduce the virulence of the organism.

The epidemiology of this important swine disease is still incomplete, but the isolation of the causative organism provides an opportunity for more detailed studies.

SELECTING WOOD FURNITURE

C. S. WALTERS and K. VIRGINIA SEIDEL

WHEN SELECTING wood furniture, you need to exercise judgment and caution, just as in buying any other product.

First of all, it's important to read the labels. There are plastics that resemble wood, for example, but they lack wood's good qualities. the old adage, "You get just about what you pay for," applies often enough in buying furniture to merit your attention. The brand name and the reputation of your local dealer are important considerations.

Some of the other things to keep in mind when selecting wood furniture are suggested in the following paragraphs. These suggestions are based on studies of wood properties and interior decoration made in the College of Agriculture, as well as on information from other sources.

Advantages of wood

Wood's natural properties make it highly suitable for furniture. One of the most striking of these properties is the beauty of grain and coloring that is found in most species of wood and that can give each item of furniture a unique quality.

Wood's natural beauty can be enhanced by artistry of design and excellence of craftsmanship. Wood is well suited to the craftsman's skills — it is easily cut to shape and fastened, and it can be carved or machined into intricate designs.

Together, inherent beauty, artistry, and craftsmanship, plus the owner's care over time, can lead to wood furniture's eventually being classified as "antique" rather than being relegated to the trash heap.

Of course, whether a piece eventually reaches "antique" status depends partly on the species of wood. Much of the beauty of antique furniture stems from the fact that such woods as walnut, mahogany, cherry, maple, birch, and oak were used. When worn, these solid woods retain their beauty, figure, and appearance.

Kind of wood also helps to determine the serviceability of a piece of furniture. If you drop a cigarette lighter on a table of pecan or ash, for example, it will be less likely to leave a dent than on a table of pine or gum.

Because wood is a poor conductor of heat, it is more comfortable to touch than metal furniture. If smoothly finished, wood is indeed very pleasant to touch. Among other good features, wood doesn't rust, and it can be refinished to cover worn spots or to change the decor.

Fresh from the tree, wood is rather heavy because it is saturated with sap, which is mostly water. When properly seasoned, however — as it must be for good furniture — wood is relatively light in weight for its strength. Besides reducing shipping charges, this comparative lightness is a boon to husbands who must periodically succumb to their wives' demands that the furniture be rearranged. Seasoning also reduces the tendency for shrinking, swelling, warping, and cracking of joints and panels.

Bad habits of wood

Depending on the degree of seasoning, wood tends to shrink and swell with changes in humidity. This can affect the strength of glue joints and cause such difficulties as "sticky" drawers. Moisture content also affects the finish.

To make sure that these "bad habits" of wood are kept at a minimum, check wood furniture for warping before you buy it. A check should be made of table tops, doors, drawer sides, chair legs, and bed rails. Warping is quite often a sign that wood was not properly seasoned.

Look for good construction

Besides checking for warping, you should also examine the construction. A number of things will help tell you about the care with which a piece of furniture was made.

One point to check is whether screws, nails or staples are used as fasteners. Screws have the best holding power and should be used where strong joints are required. Good furniture usually has few nails and fewer staples. For example, the corner blocks commonly used to strengthen the joint where a table or chair leg is attached to a rail should be glued and screwed in place — not nailed or stapled.

Legs should be attached to rails with glue and dowels or mortise-and-tenon construction (Fig. 1). Modern gluing techniques and adhesives provide a glue bond that is stronger than the wood, so the glued joint is more durable than it once was. Ask the salesman for information about the kind of joints used in the piece.

It's better if the backs of chests, hutch cabinets, and dressers are fitted into grooves rather than being stapled or nailed to legs or rails.

If a piece of furniture has drawers, an examination of the drawers will tell you a lot about quality of construction. In good furniture, drawer sides are dovetailed to both the front and the back (Fig. 2). The drawer bottoms will also be fitted into slots cut into the drawer sides and ends (Fig. 3). Drawer bottoms should be thick enough to support the contents of the drawers (¼-inch plywood is satisfactory). Thin drawer bottoms indicate cost cutting.

Do the drawers slide easily? Good construction requires that drawers ride on guide rails or a track system that uses nylon rollers. Some drawers are coated with a finish that retards moisture, thus helping to control shrinking, swelling, and warping.

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'he finish also provides a smooth ırface that reduces snagging of hoery and lingerie.

Now remove a drawer or two and ɔok inside the piece. Does it have ıst panels — that is, thin sheets plywood or hardboard between rawers? Less expensive furniture ften does not have these panels.

Check the doors to make sure that ey swing freely and do not drag on osing.

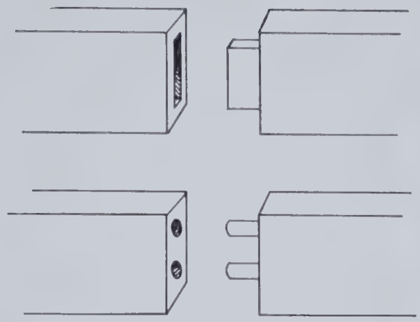
Examine the cross grain in furnire legs. This is particularly imporint in chair legs at or below the at level, where the leg may be subjcted to unusual stress. As a genal rule, the direction of the grain ıould not deviate more than 1 inch om the edge of the leg in 15 inches leg length. Otherwise the strength the leg will be seriously reduced. recent Department of Forestry udies, a grain slope of about 1:4, milar to that shown in Figure 4, reıced bending strength by at least percent.

Sometimes furniture manufacturs will steam wood to soften it, then nd it so that the grain and the ge of the leg will be parallel. If e wood is not steamed, the leg of well-constructed chair will be cut m the board in such a way that e grain in the lower two-thirds of e leg will run nearly parallel to the ngth of the leg.

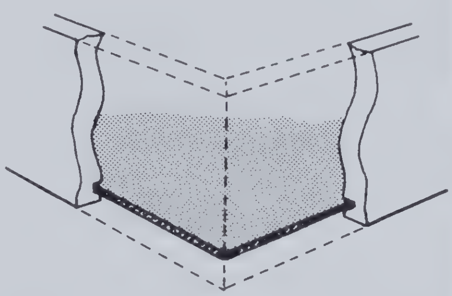
Since the buyer cannot ordinarily spect the framing of upholstered rniture, about the only test of quali is to see whether all legs touch a vel floor. A sofa frame can be sted by lifting the right front leg out 2 inches from the floor. At is point the left, front leg should so rise from the floor if the frame s been well designed and manuctured.

lid vs. veneered furniture

Solid wood, rather than veneer, s been traditionally associated with gh quality — mainly because eighenth-century craftsmen such as epplewhite, Sheraton, and Phyfe rked primarily with solid wood. neered material, however, need t be a sign of inferior quality.



Mortises and tenons are one sign of good furniture construction. (Fig. 1)



Drawer bottoms should be fitted into slots in drawer sides and ends. (Fig. 3)

Either solid or veneered material may be found in both very good and very poor furniture.

Each sheet of veneer in a plywood panel has the grain running at right angles to that of neighboring plies. Thus, in some ways the plywood panel shrinks and swells less, and it may be stiffer and stronger than a piece of solid wood. The solid wood tends to warp more than plywood.

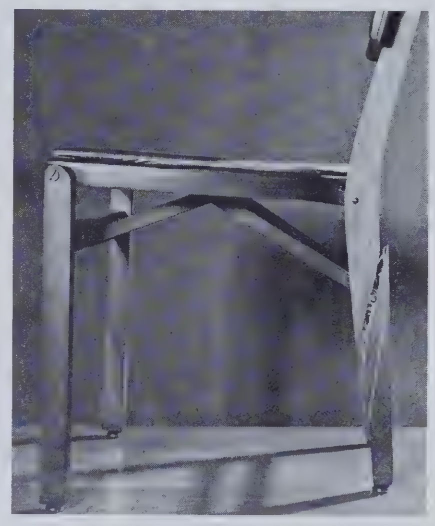
On the other hand, solid wood can be carved much more satisfactorily than veneered wood or plywood. In fact, it is almost impossible to hide veneered or plywood construction when the furniture is machined.

Finishes

Before buying a piece of furniture, ask your dealer about the finish. The finishes used on wood furniture range from a simple one consisting perhaps of a coat of stain and a single coat of lacquer, to more expensive systems that may require more than 20 steps.

Manufacturers of high-quality furniture usually provide a finish that resists wear and maintains the beauty

Drawer sides should be dovetailed to both the front and the back. (Fig. 2)



A grain slope of about 1:4 caused this chair leg to fail under stress. (Fig. 4)

of wood for a long time. Many of the newer finishes will not develop white rings from wet glasses.

Be careful of such terms as "walnut finish." Usually this means that the wood is not walnut but has been stained to look like walnut.

Take good care of furniture

Avoid exposing furniture to excessive heat and sunlight. Take care to protect the finish from scratches, cigarette burns, and spilled liquids. Last, but not least, get and follow the manufacturer's instructions on how to maintain the finish on the piece you buy.

Freezing Orange Sections at Home

AIKO K. PERRY and FRANCES O. VAN DUYNE

QUERIES are sometimes received in the Department of Home Economics concerning the advisability of freezing and storing oranges at home.

Since comparatively little work has been reported on this subject, a study was undertaken in the food research laboratory to supply some of the desired information. Specifically, the purpose was to determine how additions of ascorbic acid or sugar before freezing would affect the palatability and ascorbic acid content of the thawed products.

Procedures

Valencia oranges from Florida were peeled and sectioned and the segments were packed in pint glass freezer jars. The pieces were covered with orange juice obtained during sectioning; with juice to which 40 percent sugar by weight had been added; with juice and 150 milligrams of ascorbic acid per pint container; and with juice plus 40 percent sugar and 150 milligrams of ascorbic acid. These four treatments were replicated on three days.

Four periods of freezer storage were used — approximately 2, 5, 8, and 10 months. At the end of each period, some of the frozen segments were thawed overnight in a refrigerator. Three to seven members of the foods staff then scored the segments for appearance, color, texture, flavor, and absence of off-flavor. A 5-point scale was used with 5 corresponding to very good; 4, good; 3, fair; 2, poor; and 1, very poor. Scores for the characteristics were added to obtain a total palatability score. Ascorbic acid content of the drained sections and juice was determined by a chemical method after the last interval of freezer storage.

Palatability

Mean palatability scores for orange sections thawed and rated after 5 and 10 months of freezer storage are given in Table 1. Ratings obtained after 2 and 8 months are very similar to those in the table. After 5 and 10 months of freezer storage, mean total scores ranged from 19.6 to 21.7 (out of a possible 25), indicating that most of the taste panel members considered the products good. Although the differences in ratings for the four packs were small, some of them were still significant. Mean total scores for orange sections covered with juice and 40 percent sugar were significantly higher than for those packed only in orange juice. And segments packed in juice, 40 percent sugar, and 150 milligrams of ascorbic acid had significantly higher scores than the segments packed in juice and ascorbic acid. Adding ascorbic acid did not significantly affect the mean total scores.

Table 1. — Palatability Scores for Thawed Frozen Orange Sections

Type of pack	Mo. of storage	No. of ratings	Mean scores for individual factors					Mean total scores
			Appearance	Color	Texture	Flavor	Absence of off-flavor	
Juice	5	14	3.9	4.4	3.8	3.6	4.8	20.4
Juice+40% sugar	5	14	4.2	4.5	3.9	4.0	4.9	21.6
Juice+ascorbic acid	5	14	3.7	4.4	3.9	3.2	4.6	19.8
Juice+40% sugar +ascorbic acid	5	14	4.2	4.7	4.1	3.8	4.6	21.4
Juice	10	12	3.2	4.4	3.8	3.4	4.9	19.7
Juice+40% sugar	10	12	3.8	4.6	4.0	4.0	4.8	21.2
Juice+ascorbic acid	10	12	3.7	4.4	3.8	3.2	4.6	19.6
Juice+40% sugar +ascorbic acid	10	12	3.8	4.5	4.1	4.3	5.0	21.7

In general, the addition of sugar to the juice covering the orange sections gave them an attractive, glossy appearance and improved their flavor after thawing.

The color of all products was rated between good and very good and the texture was considered similar to that of fresh oranges.

Ascorbic acid content

After 10 months of freezer storage, ascorbic acid contents were determined in thawed orange sections and juice. The drained sections ac-

Table 2. — Ascorbic Acid Content After 10 Months of Freezer Storage

Type of pack	Ascorbic acid, mg./g	
	Drained sections	Draine liquid
Juice	.38	.39
Juice + 40% sugar	.36	.41
Juice + ascorbic acid	.74	.97
Juice + 40% sugar + ascorbic acid	.68	.89

counted for about two-thirds of th weight of the contents of a pint co tainer; the liquid, one-third.

The thawed products were goo sources of ascorbic acid (Table 2 In an earlier study, juice from Flo ida oranges purchased in 8 differe months had a mean ascorbic ac content of 0.42 milligram per gra

As would be expected, ascorb acid content was increased in t thawed products by adding ascorb acid before freezing.

Implications

Freezing Florida Valencia oran segments in juice and added sug provides a palatable, convenie product for use when this variety not on the market. It is not know however, whether results would be good with other varieties.

Aiko K. Perry is Instructor in Foods a Frances O. Van Duyne is Professor of Foo Department of Home Economics.

BETTER NUTRITION for Low-Income Families s Aim of New Cooperative Extension Program

ROL REBBE

OOPERATIVE EXTENSION programs have always been planned to lp solve specific problems and meet e needs of particular clientele oups. One group now receiving ecial attention consists of rural and ban families with limited income. he University has received special nds from the U.S. Department Agriculture so that educational ograms for this group can be panded.

Extension staff members have und that typically the low-income d disadvantaged people do not rticipate freely in group activities. hey do not join many organizations rough which they might learn. Nor they learn by reading bulletins d other educational materials. ese families will respond to personal visits by which individual tention can be given to their problems. Working on a personal one-one basis is costly, however, and Extension Service has not had staff or the funds to do as much this work as needed.

ot programs in other states

To expand the work of the Exten-n professional staff, several states ve initiated pilot programs for ining lay people from the low-ome communities as program as-ants. Under the supervision of county Extension home econo-st, these program assistants go to ir neighbors and provide personal cational help. Program assistants able to establish rapport with ir neighbors, and the families om they contact do learn and do opt new ideas. These families' in-ests then move on to other prob-s and needs. This kind of assistance gives them a new sense of value and from this comes new aspirations for the future.

Program assistants attend a class to learn how to help their neighbors.

Illinois program

The U.S. Department of Agriculture funds granted to Illinois will be used to hire program assistants in 18 counties. The county Extension advisers in home economics will train and supervise the program assistants as part of an intensive nutrition program aimed at low-income families.

Objectives of the program include helping the low-income homemaker to understand the relationship of good nutrition to the well-being of her family, to develop skills in food preparation, and to budget her food dollar so that she will get more food for her money. Since one of the most effective ways of bringing new ideas to the adult is to have them introduced by the children, the program will be directed toward the entire family.

Geraldine Acker, Foods and Nutrition Specialist, has conducted workshops for the Extension advisers. She is also developing written and visual materials to be used by the advisers in training the program assistants.

The intensive nutrition program is being concentrated in the counties where there is a large number of low-income families and where the county staffs and councils have indicated a willingness to carry out the program. The counties are Cook, St. Clair, Madison, Peoria, Tazewell, Vermilion, Macon, Champaign, Sangamon, Rock Island, Will, Winnebago, Kankakee, Franklin, Jackson, Williamson, Pulaski, and Alexander.

County Extension advisers have formed local advisory committees to help them select the areas of the county where the program is most needed. These committees have also helped the staff to recruit, interview and select qualified program assistants. Future plans call for the development of area committees to give local guidance to the program.

ol Rebbe is Project Leader for the Ex-ded Nutrition Program.

FARM BUSINESS TRENDS

INTEREST charges are a large and rapidly increasing cost for most farmers. U.S. farmers in 1968 paid about $3.1 billion for interest on debts — twice as much as in 1962 and six times as much as in 1950.

About 48 percent of the 1968 farm interest bill was for farm mortgage debt, and 52 percent was for non-real estate debt. Interest charges on both kinds of debt have been increasing at about the same rate (Fig. 1). The rising interest charges are due both to farmers' increasing need for borrowed capital and to rising interest rates.

Looking ahead, it seems likely that capital requirements will continue to increase because of rising prices and increases in the amount of supplies needed for farming. Interest rates will remain high as long as inflation continues. If inflation increases, interest rates will rise further.

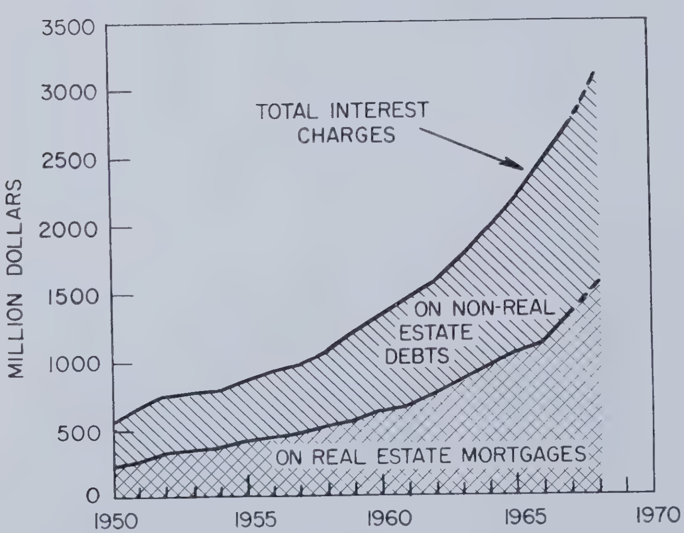
Even if the general level of interest rates does not increase further, rates charged on farm loans may rise, since these rates have not kept pace with the rise in interest rates for other loans (Fig. 2).

Interest rates are the prices that savers receive and borrowers pay for the use of money. When inflation is running strongly, savers and others with money to lend know that inflation will destroy part of the purchasing power of their money. They want enough interest to compensate them for this loss of purchasing power and to provide some additional return.

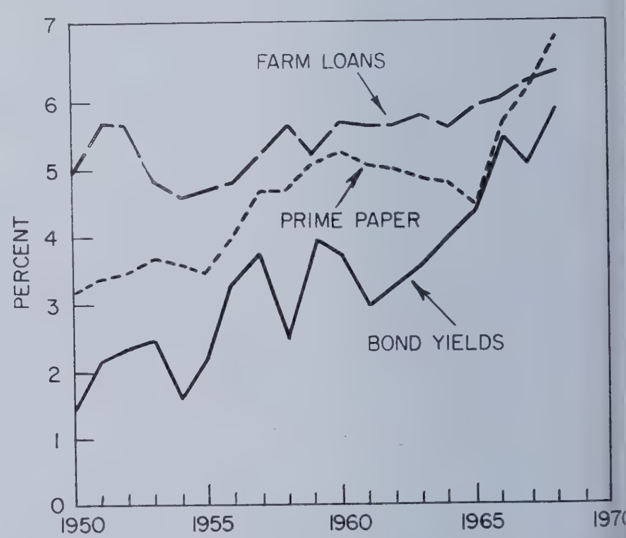
Inflation recently has been around 4 percent per year. That is, money loses about 4 percent of its value or purchasing power each year.

With this rate of inflation, suppose that a person puts $10,000 into a savings account at 5 percent interest. He will receive $500 in interest, but $400 of this amount will be needed to offset the shrinkage in purchasing power of his $10,000. In most cases all of the remaining $100 would go for income taxes, leaving him with no real income from his money.

Naturally many savers will demand a higher interest return, or they will invest their money in businesses where greater returns are expected. — *L. H. Simer*, *Professor of Agricultural Economics*



Interest charges for farm mortgage debt and non-real estate farm loans, 1950-1968. **(Fig. 1)**



Interest rates on non-real estate farm loans and on prime commercial paper, and bond yields, 1950-1968. **(Fig.**

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To:

Summer, 1969

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Students and field workers assemble for work near experimental corn plots at Njala University College, Sierra Leone (page 14).

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE Volume 11, Number 3

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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G. W. Salisbury . . . . Director

Margery E. Suhre . . . . Editor, ILLINOIS RESEARCH

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SALISBURY IS NEW DIRECTOR

ON JUNE 1 Glenn W. Salisbury began his new duties as Directo of the Agricultural Experiment Station and Associate Dea of the College of Agriculture. He succeeded M. B. Russell, wh had resigned the position to become chief of party for the Unive sity of Illinois-USAID team at Jawaharlal Nehru Agricultural Un versity, India, beginning July 1.

Dr. Salisbury came to the University of Illinois in 1947 as hea of the Department of Dairy Science. Previously he had been on th staff of Cornell University.

Among Dr. Salisbury's many honors was his appointment durir the Kennedy administration to the agricultural subpanel of th President's Science Advisory Committee. In 1966 the Italia government gave him a special citation and decoration for h contributions to the improvement of livestock in Italy after Wor War II. Other honors have included the award of merit at th Fifth International Congress on Animal Reproduction and Art ficial Insemination in Italy (1964); the Morrison award for ou standing research in livestock production (1944); and the Bord award for research in dairy production (1945).

Dr. Salisbury is a Fellow in the American Association for th Advancement of Science and belongs to about a dozen other scie tific and honorary organizations. He is co-author of a boo *Physiology of Reproduction and Artificial Insemination of Catt* and is author of some 200 scientific articles.

Dr. Russell has been with the University of Illinois since 195 serving as head of the Department of Agronomy until 1962, Associate Director of the Experiment Station from 1962 to 196 and as Director since 1965.

He was president of the Soil Science Society of America in 19 and of the American Society of Agronomy in 1963. In additic he has served on committees and boards of many state, nation and international organizations relating to soil science and ag culture. As a member of a subpanel of the President's Scien Advisory Committee, he contributed to that committee's rece study of the world food problem.

When he returns from his two-year assignment in India, plans to resume teaching and research in the Department Agronomy.

The Promise and Problems of SORGHUM-SUDAN HYBRIDS

S. L. SPAHR and
E. E. ORMISTON

N RECENT YEARS, sorghum-sudan hybrids have found a place on nany farms as a new forage crop. Their chief advantage is that they ;row rapidly in the hot days of mid-ummer, when other forages seem to tand still.

Sorghum-sudans generally respond eadily to temperature, moisture, day ength, and fertilizer, especially nitro-en. In Illinois these factors may be lose to optimum for sorghum-udans in late June and early July.

However, the very characteristic f rapid mid-summer growth, which nakes sorghum-sudans so attractive, lso creates management problems. or the rapid growth rate is accom-anied by losses in protein content nd digestibility and by increases in ber content.

rowth, nutritive value measured

Both the rapid growth and the nu-itive losses are exemplified in results f recent experiments at the Dairy esearch Farm.

Sorghum-sudan was seeded on Iay 20 in 1966 and on June 5 and une 19 in 1967. As the crop ma-ured, it was green-chopped daily ver a period of 30 days. In 1966 is green-chopping began when the ants were 15 to 25 inches tall. In 967, green-chopping was begun on oth plots when the plants on the te-seeded plot had reached a eight of about 20 inches. By har-esting both plots at the same time, was possible to test differences in age of maturity on the two plots any sampling date, and also dif-rences on the same plot at different mpling dates. The daily samples ere composited for 3-day periods.

During the sampling period the owth rate averaged 2 or 3 inches a day (Fig. 1). For the first 6 days of the 1966 period, plants grew at an average rate of 6 inches a day.

At the beginning of the sampling periods, when the crop was at a relatively early stage of maturity (the vegetative stage), the sorghum-sudans had crude protein levels similar to those usually found in legumes. During the next 30 days, however, the protein content of the sorghum-sudans declined by about 0.4 percentage point a day (Fig. 2).

The effects of stage of maturity on protein content were especially evident in 1967, when the early-seeded green-chopped forage averaged 12.4 percent crude protein, as compared with 17.8 percent for forage seeded 14 days later and chopped on the same dates as the early-seeded forage.

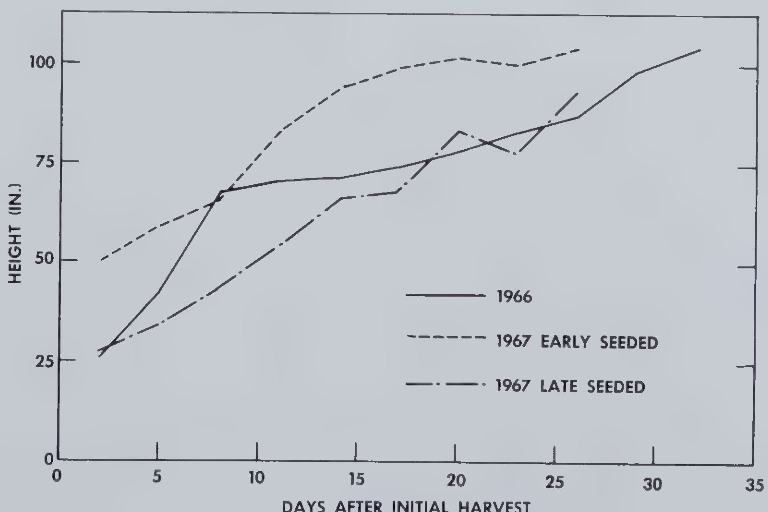
Effects of maturity were also evident in the digestibility of the forage. Changes in digestibility in 1966 are shown in Figure 3. Protein digestibility decreased at the rate of about 1 percentage point a day — from 82 percent at the beginning of the sampling period to 52 percent at the end. With both protein content and digestibility decreasing, digestible protein declined from 16.0 percent on the first sampling date to 3.4 percent 30 days later.

Digestibility of the energy and of the dry matter also decreased rapidly, particularly during the vegetative stage. Between June 27 and July 29, digestibility of dry matter decreased by about 15 percentage points; and digestibility of energy, by about 21 percentage points.

Dry matter percentage

Sorghum-sudans contain more water than most other forages. Differences between sorghum-sudans, Piper grass, and alfalfa-orchard grass were studied in 1965 and 1966. Each week, on the day before cows were turned in on new plots, the plots were sampled and analyzed for dry matter content.

The following dry matter percentages for alfalfa-orchard grass were obtained in 1965; those for the other two crops in 1965 and 1966.



Growth rates of sorghum-sudans. Initial harvest dates were June 27 in 1966 and July 18 in 1967. (Fig. 1)

L. Spahr is Assistant Professor; E. E. miston, Professor of Dairy Husbandry.

Forage	*First growth*	*Second and later growth*
Alfalfa-orchard . .	18.8	24.3
SX-11 sorghum-sudan hybrid . .	11.9	15.5
Piper sudan	14.9	18.1

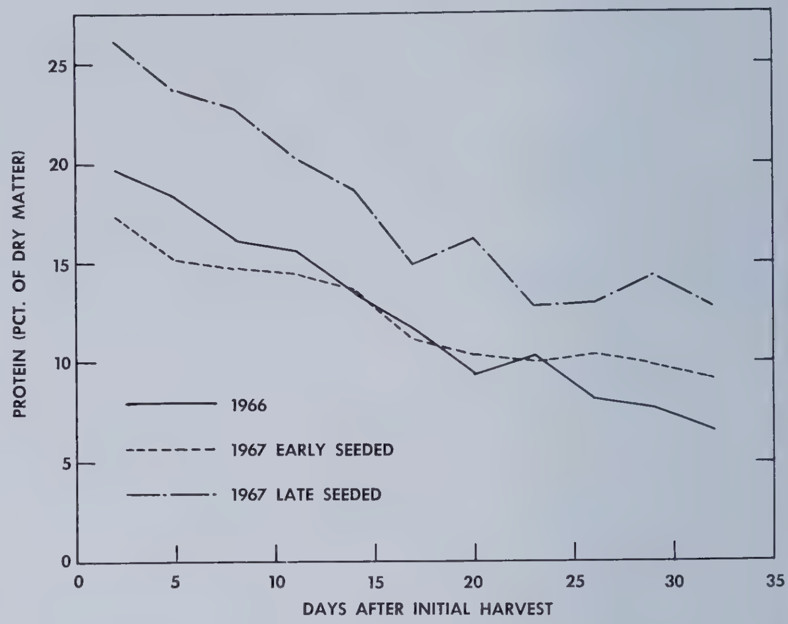
At all stages of growth sorghum-sudan had a lower dry matter content than Piper sudan or alfalfa-orchard grass. In a few sorghum-sudan samples, dry matter was less than 10 percent. Under green chop conditions the sorghum-sudan did not reach 20 percent dry matter until seeds were well formed and approximately in the milk stage.

High moisture content generally will not limit forage consumption, particularly by high-producing cows, which need large amounts of water for milk production. High moisture levels, however, do present some serious harvesting and storage problems. Seepage losses may be excessive when sorghum-sudans are stored as direct cut forage. Wilting before ensiling is difficult and slow because of the bulkiness and high moisture content of the forage.

When to seed?

Early seeding of sorghum-sudans is necessary for maximum seasonal yields. At the Dairy Research Farm, highest seasonal yields were usually obtained by planting about 10 days after the earliest corn-planting date. Over a 3-year period, 12 to 16 weeks of grazing were obtained by seeding sorghum-sudans in mid-to-late May. Seeding in late June and July resulted in only 8 weeks of grazing. A 22-week grazing period is possible with alfalfa-orchard grass.

Although late seeding reduces total grazing time, it gives peak yields late in the summer, when supplemental pasture is needed the most. For example, when the seeding date was delayed from May 20 and May 27 to June 13 and July 5 in 1966, the seasonal carrying capacity was reduced by 18 percent, but grazing in late July, August, and September was increased by 29 percent. Delaying the seeding may be advisable if a peak yield during late summer is desirable or if the land can be used for some other purpose in the spring. Weeds are generally less of a problem in late seedings than in early seedings.



Changes in sorghum-sudan protein content associated with maturity. (Fig. 2)

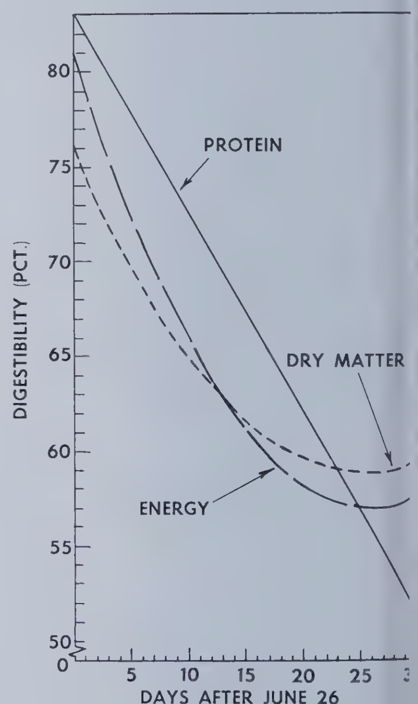
Regrowth

A system of grazing which permits 14 to 21 days for regrowth generally provided a continuous source of high-quality forage. Rate of regrowth was found to vary widely, with moisture usually being the limiting factor. In 1966 the sorghum-sudans averaged 22 inches in height only 15 days after grazing was stopped, and 28 inches after 21 days.

For maximum regrowth, it was necessary that moisture be adequate, that days be close to their maximum length, that the crop be first growth, and that it be cut or grazed at a relatively early stage (less than 30 inches). Regrowth was especially slow when the crop was cut or grazed after tasseling had occurred.

Trampling

Any type of forage, if grazed, will be damaged by trampling. Sorghum-sudans are damaged at least as much as other forages, and often more. On the Dairy Research Farm sorghum-sudans were observed to be more brittle and prone to breaking than Piper sudan grass. Rows 21



Changes in digestibility of protein, d matter, and energy associated with da of harvest. (Fig.

inches wide appeared to be trample about as much as 7-inch drilled row

Losses due to trampling becan increasingly obvious as the height initial grazing increased. Grazing a relatively immature stage growth minimized the losses.

WHO USES CATTLE FUTURES MARKETS?

M. B. KIRTLEY

FOR NEARLY five years — since November 30, 1964 — traders have)een dealing in live cattle futures on he Chicago Mercantile Exchange. \ high of 12,988 transactions on a ingle day was reached on March 28, 969. Cattle futures have also been raded at the Board of Trade since)ctober, 1966, but the volume of rade has been less there than at the /Iercantile Exchange.

Basically a futures market proides a way to shift price risk. The rain futures market is used priıarily by grain traders, other than ırmers, to carry inventories of harested grain. In contrast, cattlemen an use the cattle futures market to)rward-price their cattle while proucing and finishing them.

Questions frequently asked about ıe cattle futures market are: Who doing the trading? And how large re the individual accounts?

To help answer these questions, ıe Chicago Mercantile Exchange)operated in a survey of their clearıg house members as of July 28,)67. The information secured for ıch account was: (1) occupation customer, (2) type of account — hether speculative or hedging, and }) contract position each month.

Activity was relatively high at the ne of the survey. Open commit:ents, or unliquidated accounts, ımbered 24,025. Reports were :cured on 41,714, or 86.8 percent the 48,050 contract positions. ıch contract represented 25,000)unds of live cattle or the equivent of about 22 market steers. n August, 1969, a contract will be icreased to 40,000 pounds.)

Cattlemen were the major custmers with 50.7 percent of the total ntracts (Table 1). They held .9 percent of the short positions greements to deliver and accept yment for cattle at a later date). This indicates that they were using the market to hedge or forward-price their cattle. Yet many cattlemen evidently used their knowledge of the industry to speculate, since they accounted for 46.2 percent of the long positions (agreements to receive and pay for cattle in the future).

The livestock industry, including cattlemen, packers, and other people in the industry, accounted for 68.2 percent of the total contracts. Thus people trading in this market are generally knowledgeable about the beef business. For the satisfactory operation of a futures market, however, large amounts of speculative support from the general public are also desirable.

Number of contracts held per account averaged 11.2 (Table 2). The most frequent size of an account was two to five contracts. Accounts this size made up 1,600 of the 3,714 total. Hedging accounts averaged 23.3 contracts per account compared to 7.1 for speculators.

While the trade in live cattle futures has expanded quite rapidly, it still makes up only a small part of the cattle industry. The 24,025 open commitments at the time of this survey represent only about 530,000 cattle, less than one week's slaughter. Since the survey, open commitments have varied, reaching a high of 31,534 on March 27, 1969.

Further data of the type reported here may be available in the future, since the cattle futures market came under the regulation of the Commodity Exchange Authority of the U.S. Department of Agriculture on June 18, 1968. One service of this agency is the collection of data on trading. Comparisons of the changes which may occur over time will help in analyzing the operation of this market.

Table 1. — Occupation of Holders of Cattle Futures Contracts, Chicago Mercantile Exchange, July 28, 1967

Occupation	No. of contracts			Pct. of contracts		
	Total	Long	Short	Total	Long	Short
Cattlemen	21,140	9,339	11,801	50.7	46.2	54.9
Packing industry	4,005	853	3,152	9.6	4.2	14.7
Other, livestock industry	3,288	1,455	1,833	7.9	7.2	8.5
Professional speculator, etc.	5,615	3,731	1,884	13.5	18.4	8.8
Other	7,666	4,860	2,806	18.3	24.0	13.1
Total	41,714	20,238	21,476	100.0	100.0	100.0

Table 2. — Size Distribution of Cattle Contract Holdings, Chicago Mercantile Exchange, July 28, 1967

No. of contracts per acct.	Hedgers		Speculators		Others		Total	
	No. of accts.	No. of contracts	No. of accts.	No. of contracts	No. of accts.	No. of contracts	No. of accts.	No. of contracts
1 only	128	128	899	899	3	3	1,030	1,030
2-5	363	1,125	1,220	3,524	17	45	1,600	4,694
5-10	161	1,273	313	2,486	7	43	481	3,802
11-25	132	2,230	184	3,116	3	41	319	5,387
26-50	69	2,585	80	2,824	2	60	151	5,469
51-100	36	2,659	35	2,548	0	0	71	5,207
Over 100	41	11,675	18	4,038	3	412	62	16,125
Total	930	21,675	2,749	19,435	35	604	3,714	41,714
Average		23.3		7.1		17.3		11.2

B. Kirtley is Associate Professor of Live:k Marketing Extension.

Research Teams Fight a Killer:

ST. LOUIS ENCEPHALITIS

E. I. PILCHARD and JOHN VOLK

MOSQUITO bites proved fatal to four southern Illinois residents last fall. The insects were carrying the virus of St. Louis encephalitis, a form of sleeping sickness which is especially hard on elderly people. Besides the four who died, another 54 came down with the disease.

Early symptoms are a headache, stiff neck, and transient fever. These can be followed by mental confusion, coma, and eventually death. There is no known treatment.

St. Louis encephalitis is one of more than 100 diseases transmitted between man and animals. These diseases, known as zoonoses, also include rabies, tuberculosis, yellow fever, and brucellosis.

The University of Illinois Center for Zoonoses Research (CZR), a unique institution founded in 1960, focuses the attention of scientists from many disciplines on zoonotic disease problems. St. Louis encephalitis became a special interest of CZR when the center was called on to help halt an epidemic in McLeansboro in 1964.

The 1968 outbreak was first discovered in Eldorado, 20 miles from McLeansboro. Dr. A. G. Bledig, a local physician, suspected that the disease was in the area and asked the CZR arboviral research unit for assistance in getting rapid laboratory confirmation of his suspicion.

After asking Dr. Bledig to notify the Illinois Department of Public Health, CZR staff members began cooperating with federal, state, and local health officials in locating all suspected human cases of encephalitis in the area.

Paired sera from one of Dr. Bledig's patients were collected on September 9 and 13, and rushed to the CZR laboratory in Urbana. A four-fold rise in St. Louis hemagglutination-inhibiting antibody was found.

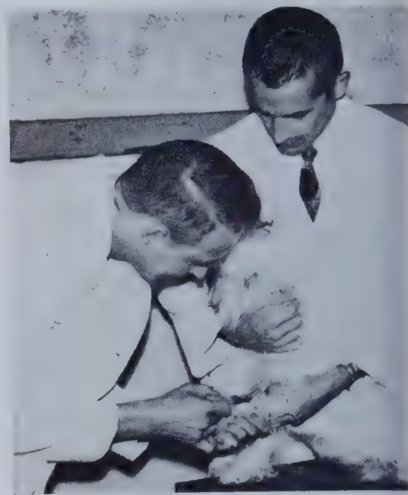
A four-man CZR field collecting team which had been gathering wildlife and insect specimens in southern Illinois shifted operations to Eldorado. As specimens and ecological data were collected, possible sources of virus were located.

Previous CZR research had shown that the *Culex pipiens* mosquito complex was responsible for spreading the disease. The epidemic proportions of the outbreak demanded immediate control of these mosquitos. Special measures for this purpose were recommended by a CZR entomologist.

Other animals were also involved. Birds — primarily house sparrows — harbor the virus and provide a medium in which it multiplies. Birds were captured in mist nets, bled, and released. Attempts were later made to isolate the virus from their blood.

Earlier CZR work suggested that privately owned dogs may serve as sentinels to help estimate temporal and geographic distribution of the virus. CZR, IDPH, and local veterinarians cooperated in collecting 378 sera from 242 dogs at sampling clinics set up at Eldorado and nearby Harrisburg. Initial serological tests showed 10 dogs were actively infected with SLE virus, 60 had had previous immunological experience with the virus, and 172 had no SLE antibody.

Despite the efforts to control the disease, the question remains: Why does St. Louis encephalitis break out periodically in the same area?



Dr. Pilchard (left) takes sample of dog's blood to be tested for SLE antibod

CZR workers collect mosquitoes in a c vert, using battery-powered aspirat that suck up the insects. Laboratory te are later made to identify the species a determine whether the mosquitoes a carrying the SLE virus.

The Center for Zoonoses Resear has been studying this question sin 1963, through federal grant suppo Researchers have been seeking re sons why encephalitis and oth zoonoses emerge and recede i human populations, and how a where disease agents survive betwe epidemics.

Throughout the last four yea researchers have maintained const surveillance on wildlife and ins populations and weather. Specim have been collected continually a tested for encephalitis virus. Te

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E. I. Pilchard was formerly Assistant Professor, Veterinary Pathology and Hygiene and Center for Zoonoses Research; John Volk was formerly Editor, College of Veterinary Medicine.

Effects of Nitrogen, Phosphorus, and Potassium on

THE SUGAR CONTENT OF SOYBEANS

THEODORE HYMOWITZ and SUSAN H. SHU

S UGARS are the third largest com- ponent of soybeans, making up bout 13 percent of present day ommercial varieties. Some of nese sugars are arabinose, glucose, ıcrose, raffinose, stachyose, and erbascose.

Raffinose and stachyose are oligo- accharides. They are primarily esponsible for the flatulence that eople often experience after con- ıming toasted, dehulled, full-fat nd defatted soybean flour. The ther sugars (monosaccharides) are igested along the lining of the small itestine. But, because the human igestive tracts lacks alpha-glactosidase activity, the oligosaccharides pass into the large intestine where they are anaerobically fermented to produce gas.

The principal value of soybeans on the world market lies in their oil and protein content. Their value might be enhanced, however, if the oil and protein content remained high and the sugar content were modified to make soybeans more acceptable for human consumption.

To determine whether soil applications of nitrogen, phosphorus, and potassium affect total sugar content, an experiment was initiated at Brownstown Experiment Field. Wayne soybeans were sown in 24-inch rows on a Cisne silt loam. The soil was limed to pH 6.2. Fertilizer rates and combinations are presented in the table at right.

Harvested soybeans were analyzed for protein by the standard Kjeldahl method, for oil by nuclear magnetic resonance (NMR), and for total sugar by the phenolsulfuric acid colorimetric method.

Soybean yields varied from 22.3 to 45.4 bushels per acre, depending on rate and combination of fertilizers. However, as shown in the table, the concentration of total sugar remained fairly constant regardless of soil treatment. Average sugar concentration was 12.5 percent, with a low of 11.8 percent and a high of 13.0 percent.

Average protein content was 41.5 percent; average oil content, 22.2 percent. Total protein, oil, and sugar content averaged about 76.2 percent of seed weight. Again, this percentage remained fairly constant regardless of type or amount of fertilizer.

There was no significant correlation between sugar and oil or sugar and protein. As was expected, however, oil content was inversely correlated with protein content.

Effect of N, P, and K on Sugar Content and on Total Protein, Oil, and Sugar Content

Fertilizer treatment, lb./A.	Mean sugar content, pct.	Total protein, oil, and sugar content, pct.
Nitrogen (N)[a]		
0	13.0	75.6
60	12.1	75.8
120	12.8	76.2
180	12.5	76.4
240	12.9	76.5
Phosphorus (P_2O_5)[b]		
0	12.6	76.9
30	12.5	76.2
60	12.5	75.7
90	12.5	76.5
120	12.4	75.2
Potassium (K_2O)[c]		
0	11.8	77.2
40	12.7	77.6
80	12.3	76.8
120	12.5	76.0
160	12.4	76.4

[a] Nitrogen plots received 60 pounds of P_2O_5 and 80 pounds of K_2O per acre.
[b] Phosphorus plots received 120 pounds of nitrogen and 80 pounds of K_2O_5 per acre.
[c] Potassium plots received 120 pounds of nitrogen and 60 pounds of K_2O per acre.

Evidently any modification of the sugar content in soybeans must be done by breeding. The oil and protein contents of soybeans are genetically controlled by the maternal parent and it has been possible to derive genetic lines which are high or low in oil and protein. It is reasonable to assume that the sugars in the soybean are also conditioned by genetic factors and that it should be possible to derive genetic lines high or low in sugar content. Additional investigations are therefore being initiated to develop soybean lines that vary in total sugar content and in the kinds of individual sugars.

Theodore Hymowitz is Assistant Professor of Plant Genetics; Susan H. Shu is a Graduate Research Assistant in Agronomy.

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ncephalitis . . . (Concluded)

rus has been isolated in and around IcLeansboro every summer since 964. In addition, laboratory work Urbana has focused on determin- g which animals were susceptible encephalitis.

The research on encephalitis is ecessarily broad-spectrum. *Culex piens* mosquitoes, for example, are esent throughout Illinois and other ırts of the country. They prefer ul stagnant water such as that und in unflushed drainage ditches, culverts, and around ponds. If is kind of surface water is elim- iated, diseases such as hepatitis d Q fever can be controlled along th encephalitis.

The Center utilizes the abilities experts from 14 scientific disci- nes, ranging from geography to terinary medicine. In this most cent encephalitis project, the re- ırch teams included individuals presenting virology, immunology, tomology, ornithology, wildlife nagement, geography, and public alth epidemiology.

Should Farmers Build More Conditioning and Storage Facilities for Corn?

JOHN T. SCOTT, JR.

THE PROPORTION of corn shelled at harvest has skyrocketed from 36 percent in 1962 to 65 percent in 1968. As present corn pickers wear out, we can expect a continuing shift to field-shelling.

The increase in field-shelling has been paralleled by a similar increase in shelled-corn storage. Since 1963, farm storage has increased by 221 million bushels; elevator storage, by about 125 million bushels. Corn dried on farms increased even more — by 252 million bushels, while corn dried at elevators increased by only about 50 million bushels.

If most of our corn crop in the future is field-shelled, and if we continue to produce about a billion bushels a year, 200 to 300 million bushels of additional shelled-corn storage will still be needed.

Where should these facilities be built — on farms or at elevators? To help answer this question, we recently studied levels of investment needed, operating costs, and possible net returns for on-farm conditioning and storage facilities. Costs and returns for several batch-in-bin systems were budgeted.

The size of the systems was based on the rate of harvest by six sizes of combines (Table 1). To be effective, a dryer must dry corn at the combine harvest rate, beginning at a high moisture level.

We selected six typical market patterns and allowed two beginning-harvest corn moisture levels — 28 and 25 percent — for each pattern. The six patterns are as follows:

1. **Sell at harvest directly from the combine.** No drying and storage facilities are needed.

2. **Dry to 20 percent and sell directly at harvest.** This often reduces moisture discount rates.

3. **Dry to 20 percent and store under high aeration until March.** This is about the time of highest corn prices before 20-percent corn has to be sold or dried further.

4. **Dry to No. 2 corn (15.5 percent) and sell at harvest.**

5. **Dry to No. 2 corn and store under low aeration until July.**

6. **Dry to about 13 percent and store without aeration.**

Other factors that affect equipment size and operating cost had to be considered, including yield, field losses during harvest, rate of drying in the field, and amount of moisture and handling shrinkage.

We assumed a yield of 100 bushels of corn at the beginning of harvest, adjusted to No. 2 basis; field loss rates reported in Illinois; the average rate of natural field drying found in an Iowa study; and a 0.5-percent handling loss. Using these data, we calculated the amount of corn at each field moisture level that would have to be dried each day. Investment and operating costs were calculated for the drying facilities needed for each market pattern and each harvest rate. Similar cost calculations were made for storage.

Costs were obtained from an equipment manufacturer, and usual budgeting procedures were used to calculate depreciation, interest on investment and on corn in storage, taxes, insurance, and annual repair and operating costs of the dryer and aeration equipment.

Initial investment cost

The initial investment varies with the beginning moisture level at harvest, market pattern, and scale of operation (Table 2A).

No conditioning and storage investment is needed for pattern 1 (selling the corn from the field). Drying to 15.5 percent and selling at harvest (pattern 4) requires a[n] initial investment about 50 percen[t] greater than drying to 20 percen[t] and selling at harvest (pattern 2). However, the initial investment f[or] drying and storing at 15.5 percen[t] (pattern 5) is ony slightly more tha[n] for drying and storing at 20 percen[t] (pattern 3). The greater investme[nt] in drying equipment to reduce co[rn] to the No. 2 basis is offset by th[e] smaller amount of aeration equip[-]ment and storage space needed f[or] low-moisture corn.

Annual and operating costs

Dryer operating costs depen[d] mainly on beginning harvest moi[s]ture, rate of drying in the field, h[u]midity of the outside air, and fin[al] moisture level of the corn.

All these factors were considere[d] in calculating the annual and ope[r]ating costs shown in Table 2B. Dr[y]ing costs per bushel are lowest (2.[?] cents) for drying from 25 perce[nt] moisture to 20 percent in the large[-]scale operation. Costs range up to [a] high of 6.84 cents a bushel for dr[y]ing from 28 percent to 15.5 perce[nt] in the smallest operation. The co[st] of drying to 15.5 percent moistu[re] are 50 to 100 percent greater th[an] drying to 20 percent moisture. [In] the largest operations costs are [?] to 25 percent less than in the sma[ll]est operations.

Additional annual and operati[ng] costs for storage and aeration ran[ge] from 10 to 12 cents a bushel, wi[th] a maximum economy of about [?] percent from the smallest to t[he] largest operation.

Possible returns

Possible returns for the differe[nt] market patterns were compared wi[th] the returns for marketing direc[tly] from the combine at 28 perce[nt] moisture. The price assumed f[or]

John T. Scott, Jr., is Associate Professor of Agricultural Economics.

Table 1. — Combine Sizes and Corn Harvest Rates

Combine size	A. per day	Bu./day, beginning harvest at — 28% moisture	25% moisture	A. per season
2-row, 40″	14.0	1,596	1,527	310.8
3-row, 40″	21.0	2,394	2,291	466.2
4-row, 40″	27.8	3,169	3,033	619.4
3-row, 30″	15.8	1,801	1,724	350.8
4-row, 30″	21.0	2,394	2,291	466.2
6-row, 30″	31.5	3,591	3,437	699.3

No. 2 corn at harvest was $1.00 per bushel, with a discount of 1 cent for each half point of moisture from 15.5 to 20.5, and 1.5 cents for each half point above 20.5 percent. Price was assumed to increase to $1.10¾ in March and $1.13 in July.

Net returns per bushel above all costs for conditioning and storage are shown in Table 3A. They range from a loss (when starting harvest at 25 percent moisture and drying to 20 percent in the smallest operation) to a high of almost 6 cents a bushel (when starting harvest at 28 percent, drying to 15.5 percent, and storing until July).

Market pattern 6 (drying to 13 percent) is less profitable than pattern 5 at all sizes of operation.

Table 2. — Initial System Investment Cost and Operating and Annual Conditioning and Storage Costs for Each Market Pattern and Corn Volume

Market pattern	2R-40″ 28%	2R-40″ 25%	3R-30″ 28%	3R-30″ 25%	4R-30″ or 3R-40″ 28%	4R-30″ or 3R-40″ 25%	4R-40″ 28%	4R-40″ 25%	6R-30″ 28%	6R-30″ 25%
A. Initial investment cost, cents per bushel										
2	18.43	18.52	27.22	17.45	20.80	15.15	17.98	16.33	16.22	14.41
3	59.48	52.59	57.27	54.03	51.64	46.13	50.00	48.51	50.35	48.71
4	34.88	31.40	32.74	28.92	30.09	22.12	30.49	19.52	27.42	20.65
5	60.49	61.62	60.81	57.13	56.28	53.09	53.76	50.46	51.04	47.96
B. Operating and annual costs, cents per bushel										
2	3.23	2.83	4.37	2.69	3.57	2.40	3.21	2.60	3.00	2.36
3. Storage only	12.02	10.85	9.97	11.11	9.91	9.94	9.97	10.00	10.80	10.47
Storage and drying	15.25	13.68	14.34	13.80	13.48	12.34	13.18	12.60	13.80	12.83
4	6.84	5.98	6.60	5.66	6.07	4.81	6.14	4.50	5.72	4.50
5. Storage only	11.28	11.77	11.55	11.65	11.43	11.97	10.98	12.19	10.93	11.70
Storage and drying	18.12	17.75	18.15	17.31	17.50	16.78	17.12	16.69	16.65	16.20

Table 3. — Net Gains and Losses for Conditioning and Storage and Rate Earned on Investment

Market pattern	2R-40″ 28%	2R-40″ 25%	3R-30″ 28%	3R-30″ 25%	4R-30″ or 3R-40″ 28%	4R-30″ or 3R-40″ 25%	4R-40″ 28%	4R-40″ 25%	6R-30″ 28%	6R-30″ 25%
A. Net gains or losses, cents per bushel										
1	0	2.66	0	2.66	0	2.66	0	2.66	0	2.66
2	2.76	NL[a]	1.63	NG[b]	2.43	.42	2.79	.22	2.99	.46
3	1.53	NL[a]	2.44	NL[a]	3.31	1.27	3.61	1.01	2.98	.78
4	3.30	.81	3.54	1.13	4.08	1.98	4.00	2.29	4.18	2.29
5	4.93	3.29	4.91	2.80	5.56	3.22	5.93	4.35	5.85	4.84
B. Rate earned on investment, percent										
2	17.99	2.99	8.98	3.77	14.66	5.79	18.52	4.36	21.46	3.20
3	5.58	2.95	7.26	2.66	9.40	5.75	10.22	5.08	8.92	4.60
4	12.53	5.58	13.81	6.90	16.56	11.95	16.13	16.16	18.25	14.08
5	11.15	8.34	11.07	9.52	12.87	11.03	11.04	8.63	14.47	13.09

[a] Negligible loss per bushel. [b] Negligible gain per bushel.

Return on investment

Expected rate of return for each alternative investment is given in Table 3B. The highest return was for drying from 28 to 20 percent moisture without storage; the second highest return, for drying from 28 to 15.5 percent without storage.

The return on storage alone when storing only until March ranges from zero to 5.8 percent — too low to justify investment at the current interest rate. The return on storage alone when storing until July ranges from 4.8 to 12.3 percent — still too low for many landlords if they furnish storage for the tenants' corn.

Conclusions

Considering only economics, few landlords could afford to build storage for both the tenants and themselves. Some landlords, however, may want to build storage to offset tenant input or keep a good tenant.

Drying on the farm is usually profitable. If recent moisture-discount rates and drying charges persist at local elevators, farmers are likely to make sizable investments in on-the-farm drying equipment.

However, elevators can usually dry corn cheaper than most farmers and are likely to have a longer drying season. Also, the elevator can blend corn to the desired grade. As a rule, elevator operators watch the moisture and condition of the corn closely, and are better trained in handling grain than most farmers.

As elevators increase their handling capacity, drying charges and moisture discount rates should be lowered, reducing the profitability of on-farm drying. Even so, farmers will likely continue to provide some drying and storing facilities as a means of lowering risk at harvest and controlling their corn longer.

Woody Ornamental Plant Growth as Related to Nitrogen Applications

MARTIN M. MEYER, JR., and WALTER E. SPLITTSTOESSER

WHEN TO FERTILIZE woody ornamental plants is a question concerning homeowners, nurserymen, park managers, and others who hope to beautify the environment.

The answer to this question is determined by the growth habits of these plants. As perennials, the woody plants have developed some interesting growth patterns that enable them to survive outdoors the year round.

These growth patterns are of two basic types. The first type of growth starts as a rapid spurt in the spring when the temperature rises and the days grow longer. This spurt lasts for six to eight weeks. During this time the shoots and leaves that have been preformed in the resting bud expand and grow rapidly. This growth then stops and new buds are developed. The leaves continue to make food and the roots continue to absorb minerals. However, the food and minerals are used for increasing the diameter of the stem and are stored in the stems as reserve materials for the rapid initiation of growth the following spring.

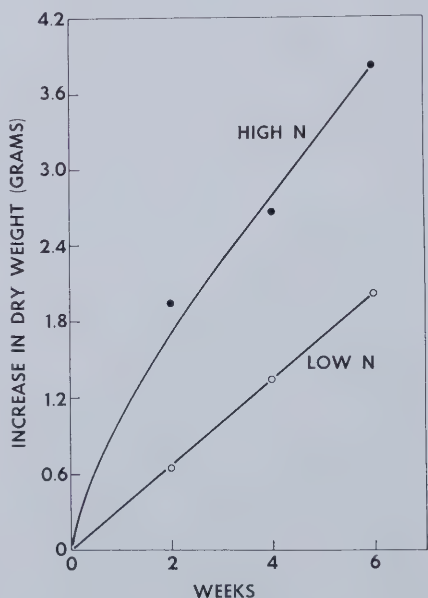
The second type of growth starts in the spring similarly to the first type. However, the plants initiate more leaves and grow for longer periods. They also respond more quickly to favorable environmental conditions. Although plants with the first type of growth can also respond to favorable conditions, this response takes the form of another rapid spurt of growth.

These growth patterns often make it difficult to measure the response of woody ornamental plants to fertilizer applications. Some of the applied fertilizer may be used for an immediate growth response and some may be stored for future use — that is, rapid growth in the spring. Woody plants mature and become dormant in the fall, and the buds, roots, and stems must survive the winter. Any treatment that speeds up growth and delays maturity late in the fall may cause winter killing and die-back.

The differences between the two types of growth patterns were brought out in recent studies of lilac and juniper plants. The studies were initiated to determine the amount of growth made by these plants and the timing of this growth in response to nitrogen fertilization.

Studies with lilacs

A one-year study was made of lilacs (*Syringa vulgaris* 'Charles Joly'), plants which follow the first basic type of growth pattern. A low-level of nitrogen was compared with a high level of nitrogen on plants growing in 3-quart pots. The high leve[l] of nitrogen was applied every tw[o] weeks during the summer as an am[-]monium nitrate solution containin[g] 200 ppm of nitrogen. The low leve[l] of nitrogen included only the nitro[-]gen already in the growth medium.



Growth of lilacs during the 6 weeks after bud break, as influenced by nitrogen application the previous season. (Fig. 1)

Plants receiving the high level o[f] nitrogen had darker green leave[s] than the others, but increases i[n] growth during the summer wer[e] minor.

In the fall, the plants were allowe[d] to become dormant naturally. Th[e] following spring, the plants were re[-]moved from the pots, the growin[g] medium was washed off the roots and the plants were repotted in [a] fresh medium with a low nitroge[n] analysis. They were then allowed t[o] grow in a greenhouse with a nigh[t] temperature of 65° F., a day temper[-]ature of 75° F., and a day length o[f] 14 hours.

Plants that had received the high nitrogen treatment the previou[s] summer started growing much faste[r] than the low-nitrogen plants and af[-]ter 2 weeks had twice the dry weigh[t] increase (Fig. 1). This ratio wa[s] maintained for a 6-week samplin[g] period. During this 6 weeks, th[e] buds on the high-nitrogen plants in[-]creased over 20 times, indicating tha[t] large amounts of material were be[-]ing transported to this new growt[h].

Even in the low-nitrogen plant[s]

Table 1. — Changes in Total Nitroge[n] in Lilac Shoots During the 6 Weeks After Bud Break

Week after bud break	N content (mg. per plan[t])	
	Low N plants	High N plants
0	2.7	7.0
2	31.5	77.7
4	36.5	94.4
6	50.5	96.2

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Table 2. — Effects of Summer Nitrogen Application on Summer and Spring Growth and Nitrogen Content of Juniper

Measurement date	ppm of N applied (1967) 0	100	200
Increase in height, cm.			
Summer (1967).....	8.2	17.4	21.5
Spring (1968)[a].....	30.0	37.8	44.8
N content, pct. dry wt.			
Summer (1967).....	1.24	1.27	1.41
Spring (1968)......	1.19	1.23	1.21

[a] This growth was measured from leader plus three longest branches.

onsiderable amounts of nitrogen moved into the new growth. During weeks the nitrogen content of the hoots increased from 2.7 milligrams (in the bud stage) to 50.5 milli-rams (Table 1). The plants that had received high nitrogen levels, owever, contained twice as much N s the low-nitrogen plants.

tudies with juniper

Effects of different nitrogen levels n growth of junipers (*Juniperus hinensis* 'Keteleeri') were also stud-ed. Like the lilacs, the junipers were rown in 3-quart containers. The rowth medium, consisting of equal arts of soil, peat, and aggregate, was w in nitrogen.

During the summer of 1967, three vels of nitrogen were tried: no xtra nitrogen, 100 ppm applied as mmonium nitrate solution every 2 eeks from June 26 to September 6, d 200 ppm applied the same way. he following spring, the same three vels were superimposed on the pre-ous summer's nitrogen levels, mak-g nine treatments in all. Nitrogen pplications were made every two eeks from April 15 to July 1.

Growth was measured in the sum-er of 1967 and in the following ring. Table 2 shows the summer d spring growth of plants receiv-g the three levels of treatment in 967 without any additional nitro-n in 1968. The junipers responded most immediately to the nitrogen pplications, and by the end of the summer of 1967, the plants receiving 100 ppm every two weeks had grown twice as much as those not receiving nitrogen, and the plants receiving 200 ppm grew 2½ times as much as the no-nitrogen plants. Nitrogen application also increased the nitrogen level in the foliage.

The following spring, plants that had received nitrogen during the summer continued to grow faster than the no-nitrogen plants. Nitrogen content of the new growth, however, was no greater in the plants that had received nitrogen than in the others.

After nitrogen was applied during the spring, the plants responded with increased growth, regardless of the previous season's nitrogen application. This is illustrated in Figure 2, which shows the effects of four levels of nitrogen (no extra N, 200 ppm in summer, 200 ppm in spring, and 200 ppm in both seasons).

Plants receiving no nitrogen in either season grew very little although they were green and healthy-looking. Plants that received nitrogen only in the spring were about the same size as those that had received nitrogen only in the summer. The spring-treated plants, however, were greener and contained more than twice as much nitrogren as the summer-treated plants.

Effects of applying nitrogen in both summer and spring were additive. Plants receiving 200 ppm of nitrogen in both seasons made the most growth and were darker green than the others.

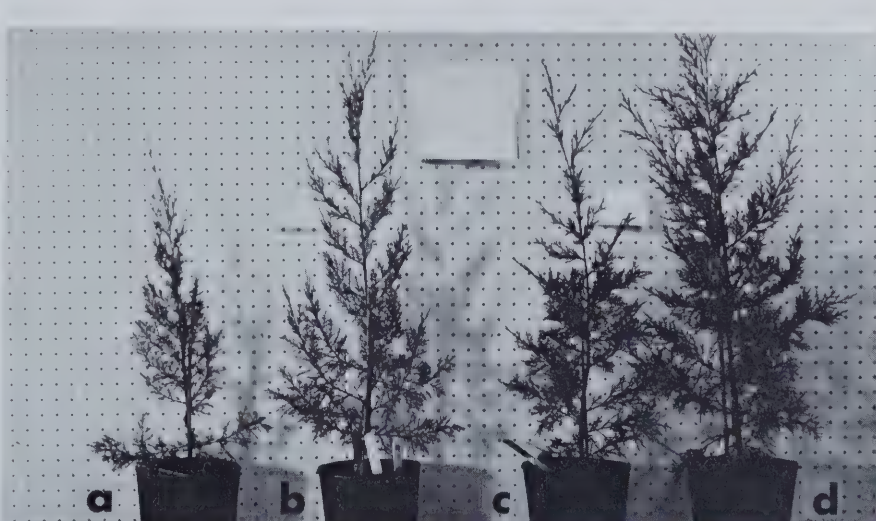
The response of juniper to the different treatments indicates that it is one of those plants that grow continuously during favorable conditions and respond immediately to nitrogen.

Plants were stored outdoors during the winter with the pots placed close together. The block of pots was protected by straw and a snow fence. There was no apparent winter damage at any nitrogen level. However, one could hypothesize that, because of the juniper's immediate response to nitrogen, heavy applications in late summer might cause winter injury to new growth.

Basic differences

These studies point up some of the differences between the two basic types of woody plants and their growth response to nitrogen.

The growth of lilac during the spring responds markedly to nitrogen applied the previous season. Juniper growth, on the other hand, is immediately stimulated by nitrogen. Although there are some carry-over effects, a continuous level of nitrogen appears important to the growth of these plants.



Growth of junipers as affected by nitrogen applications: (a) no N applications; (b) 200 ppm N summer 1967, no N spring 1968; (c) no N summer 1967, 200 ppm N spring 1968; (d) 200 ppm N both summer 1967 and spring 1968. (Fig. 2)

How, Where, and With Whom Do Today's Families Spend Their Leisure Time?

JOAN M. SAMPSON and
MARILYN M. DUNSING

In a recent survey, husbands and wives were found to spend most of their leisure time at home, either alone or with members of their immediate family

THESE DAYS we read and hear a great deal about the increasing leisure time of Americans. Both men and women are presumed to share in this boon as the length of the work week declines and as household gadgets free women from many time-consuming chores.

How much leisure time do people actually have? How, where, and with whom is it spent? How much do people invest in recreational equipment? To find some answers to these questions, and also to suggest guides for future studies, a pilot study was recently undertaken in the Department of Home Economics.

For the study, 50 families including both a husband and wife living at home were selected by a stratified, random sampling technique. The families lived in a subdivision in Champaign in houses originally priced from $11,000 to $18,000. Information was collected by the interview-questionnaire method, with the interviews being conducted by one of the authors.

Sample characteristics

The couples in the study had been married an average of 8.2 years. The husbands were slightly older than the wives. Average age of the husband was 32; that of the wife, 31. On the average, the husbands, with 13.7 years of schooling, had slightly more education than did the wives, who had 12.9 years of schooling.

Of the husbands, 56 percent were classified as white collar workers, 36 percent as blue collar, and the rest as military personnel or students. The median income of the families was between $6,000 and $7,000. On the average, the families had 2.1 children, and the average age of the children was 6.1 years.

Meaning of leisure time

During the interviews, each wife was asked what leisure time meant to her. The replies could be divided into three broad groups.

One group included definitions of leisure time as freedom to make a choice of activity or freedom for self-expression. One woman, for example, considered leisure time as the time to relax and do what she wanted to. Another said it was being able to do anything she wanted to do such as gardening or making something for the house.

The second group of definitions centered around the idea that leisure time is freedom from household duties or work. One woman said it was the time when she was not worrying about undone chores. According to another woman, leisure time was what was left over after her necessary work was done.

Freedom from obligations to the children was the basic idea in the third group of definitions. "Getting away from the kids" was the way one woman defined leisure time. Another said that it was the period when someone else cared for her children.

Half the homemakers gave definitions that fell into the first group - that is, leisure was defined as fre dom to choose activities or freedo for self-expression. Twelve, or percent of the women, defined lei ure as freedom from househo duties or work. Seven, or 14 pe cent thought of leisure as freedo from obligations to the childre The other six women mentioned tw or three of the definitions.

Hours of leisure time

The first definition of leisure tin — that it is the time in which o can do the things he really wan to — was the one used in this stud The amount of "leisure time" wou thus vary according to each pe son's idea of what was work ar what was a leisure-time activity.

Two figures were obtained for th amount of leisure time. One figu was the respondent's estimate; th other was the actual amount, base on a record of one week's activitie Both men and women turned o to have more leisure time than th thought they did. Women estimate that they had 27.2 hours of leisu time a week, but they actually ha 42.4 hours, or 56 percent more tha was estimated. Men estimated th they had 23.3 hours of leisure, bu the actual amount was 33.4 hours, 44 percent more than their estimat

On the basis of estimated hours

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eisure, wives had 17 percent more eisure time than their husbands. According to the actual figures, how- ever, the women had 27 percent nore leisure time than the men.

\ctivities

In the use made of leisure time, 11 ctivities predominated: watching elevision, conversation, sports, house nd car care and repair, sleeping nd resting, reading, attending novies, shopping, playing cards and ther games, driving, and engaging n church and religious activities.

As might be expected, watching elevision was the most important lei- ire-time activity, in terms of hours pent. Husbands, on the average, evoted 7.7 hours a week, or 23 per- ent of their leisure time, to viewing V, with 90 percent saying that they pent some time during the week n this manner. Wives devoted an verage of 10.6 hours, or 25 percent f their total leisure time, to watch- ng television. All but three of the ives, or 94 percent, reported spend- g some time in this way.

The next most important leisure- me activity was conversation, with usbands spending an average of 5.8 ours a week in this way, and wives pending 10.0 hours. Conversation as reported as a leisure-time activ- y by 92 percent of the husbands nd 94 percent of the wives.

For the husbands, two activities ed for third place—house and car re and repair, and participation sports. An average of 4.7 hours as spent on each activity. For the ves, these same two activities most tied for third place, with 3.6 ours being spent on house and car re and repair, and 3.5 hours being voted to sports.

cation

Both husbands and wives, on the erage, spent more of their leisure ne at home than away from home. usbands spent 64 percent of their sure hours at home; wives, 68 per- nt. Average number of leisure- ne hours spent at home was 28.7 the wives and 21.2 for the husbands. The wives spent 13.7 hours of leisure time away from home; the husbands, 12.2 hours.

Companions

With whom did the husbands and wives spend their leisure time? The answers fell into seven categories: (1) alone, (2) only with the spouse, (3) only with the children, (4) with both spouse and children, (5) only with people outside the immediate family, (6) only with spouse and others outside the immediate family, and (7) with spouse, the children, and others outside the family.

Husbands spent more of their leisure time with their wives than with any other person or group. They spent 33 percent of their leisure time only with their wives and 21 percent with their wives and one or more of their children. Another 21 percent of their leisure time was spent alone and 2 percent was spent only with their children. Altogether, then, they spent more than three-fourths of their leisure either alone or with their immediate families without any outsiders.

The average husband accounted for the rest of his leisure time as follows: 9 percent was spent with his wife and other persons outside the immediate family; 8 percent only with people outside the family; and 6 percent with his wife, children, and others.

The wives spent more of their leisure time alone than with any other one person or combination of persons. On the average, they spent 28 percent of their leisure hours alone. The second highest number of leisure hours, 26 percent of the total, was spent with their husbands alone. Another 17 percent of their leisure time was spent with their husbands and children, and 4 percent was spent only with their children. Thus, like the husbands, the wives spent about three-fourths of their leisure time either alone or only with members of the immediate family.

In addition, the average wife spent 14 percent of her leisure time with only people outside her immediate family, and 5 percent with husband, children, and others.

If we consider the total amount of leisure time that husbands and wives spent with each other, either with or without children and other people, we find that husbands spent 69 percent of their leisure time with their wives, and wives spent 55 percent of their leisure time in the company of their husbands.

Now let us consider the total amount of leisure spent with the children, either with or without others. Husbands spent 29 percent of their leisure time with their children, usually with somebody else around. Wives spent 26 percent of their leisure time with their children.

Again, compare the total time spent with people outside the immediate family, with or without other family members. For the husbands, the time spent in this way added up to 23 percent of their total leisure time; for the wives, 26 percent.

Expenditures

When asked about expenditures for recreational equipment, 42 percent of the families said they had spent less than $900 during marriage; 26 percent, $900 to $1,200; and 2 percent, $1,200 or more. The greatest expenditure was for musical and electronic equipment. This was followed by photographic equipment, while shop tools were the third highest in total expenditure.

Additional studies needed

The findings of this pilot study indicate that additional studies should be made with more families. It would be desirable to determine the effect of selected family characteristics (for example, educational level, age, occupation, income, number and age of children) on the choice of leisure-time activities and expenditures.

Such studies would aid individuals and organizations concerned with families' leisure-time activities and the evaluation of these activities.

Illinois Helps To Establish a New College in Sierra Leone

WALTER G. ROCKWOOD

On February 12, 1969, the University of Sierra Leone granted an honorary degree to University of Illinois President David D. Henry. Mention the award to someone not particularly versed in African affairs, and three questions are likely to be asked: Where is Sierra Leone? What kind of university does it have? And why did the university give a degree to President Henry?

Answers to the questions unfold an interesting story of growing University of Illinois influence in West Africa.

Sierra Leone nestles into the coast of West Africa between Guinea and Liberia. Half the size of Illinois, it depends on diamonds, iron ore, and agricultural exports for foreign exchange and on an underdeveloped agriculture to feed its 2.5 million population. Four out of five Sierra Leoneans make their living directly from agriculture. Per capita income is estimated at $110 a year.

Sierra Leone's Fourah Bay College, founded in 1827 and until recently affiliated with the University of Durham, England, was the first university in sub-Sahara Africa. Fourah Bay graduates hold responsible positions all over English-speaking West Africa.

Britain granted Sierra Leone independence in 1961. The new nation immediately started its struggle to emerge from poverty and attain self-sufficiency. With a well-established university already in existence, it was natural that the new government would turn to higher education as its pathway to progress.

Assistance was requested from the U.S. Agency for International Development (USAID) in 1962. In July of that year, representatives of the Sierra Leone government and USAID visited five U.S. universities, including the University of Illinois. A University of Illinois study team was sent to Sierra Leone in February, 1963, and within two months had presented a report to the Sierra Leone government.

The report recommended that "a new integrated agricultural and educational institution be developed, and that it be mandated to conduct research, instructional, and extension programs in direct response to the goals and aspirations of Sierra Leone."

Specifically, the Illinois team recommended creation of Njala University College. Sierra Leone accepted the Illinois recommendation and Njala University College was authorized on June 1, 1963. The University of Illinois signed a contract on August 16, 1963, to help develop the new institution.

Within two months University of Illinois staff members began arriving in Sierra Leone. Their job was to help build facilities, assemble a staff, select students, and prepare to open Njala University College in September, 1964.

Njala opened on schedule with 101 students. Since then, Njala University College and Fourah Bay College have been organized into the University of Sierra Leone, one of the most promising educational systems in Africa.

In June, 1968, 44 of the first students to enter NUC passed final examinations in agriculture, home economics, and education. Their degrees were awarded February 12, 1969, during the same Congregation of the University Court of Sierra Leone that honored President Henry. Fifty-two more are expected to graduate this year.

There are good reasons for th recognition given to President Henı and the University of Illinois:

- More than 20 of the best teacl ers, researchers, and advisers tl University could send, most from tl Colleges of Agriculture and Educa tion, have served at Njala. The have helped build a program teaching, research, and extension.
- Hundreds of man-hours at tl University of Illinois have been d voted to planning the Njala projec as well as to backstopping the Illino staff in Sierra Leone.
- More than $1.5 million of U. funds have been spent under tl University of Illinois contract staff and equip Njala University.
- Fifteen Njala staff members ha attended the University of Illinc for advanced study and for trainiı in university administration.

M. R. Karnes, College of Educ tion, heads the 10-man, Universi of Illinois team of specialists now Njala. Karnes says there has be solid progress since Njala started 1963. The teaching program h

A coed washes dormitory windows as p of the work program in which all NU students are required to participate.

Walter G. Rockwood is an Assistant, Agricultural Communications.

been strengthened in spite of severe budget cuts; an agricultural experiment station is in the planning stage; and agricultural extension activity has started around Njala.

The Njala program is supported by four ministries: Agriculture and Natural Resources, Development, Education, and Finance. This support reflects the high priority that the government of Sierra Leone gives to agricultural development.

What impact will Njala University College have on Sierra Leone? According to Karnes, the extension demonstration area around Njala should show a visible impact within the next 10 years. As for Sierra Leone as a whole, Karnes reminds us how long it took the University of Illinois to make an impact on Illinois agriculture. One day, he says, the influence of Njala will be visible in all of Sierra Leone.

The long-term objective of the University of Illinois in Sierra Leone s to assist Sierra Leoneans at Njala n developing a sound program of eaching, research, and extension or agriculture. But there's another bjective often stated by Illinois speialists at Njala — to go home. We re developing Njala University College with the hope that we can go ome and let the Sierra Leoneans et on with development themselves.

The administration building is typical of campus buildings existing when school opened in 1964. Many new buildings have been added since then.

Rice research is carried on in experimental rice paddies near the NUC campus. A workers' shelter is in the background.

r. Joseph Kastelic assists NUC Registar Henry Lynch-Shyllon ith student registration. Dr. Kastelic was animal science adviser t NUC during 1964-1966.

Dr. Kastelic helps students and workers shuck oil palm fruits. Oil from these fruits is the main food fat in Sierra Leone. NUC is trying to increase oil production.

Water Table Fluctuations in Some Illinois Soils

J. B. FEHRENBACHER,
J. D. ALEXANDER,
and G. W. HUDELSON

HIGH water tables are often a problem in many flat or depressional Illinois soils. Crop growth, building and road construction, public and animal health, basements, and septic tanks and other installations may all be impaired wherever the water table is too near the soil surface.

Nearly level, poorly and somewhat poorly drained soils are likely to have high water tables in late winter and early spring. When rainfall is unusually heavy, water tables may also be high in the fall. Moderately well drained soils may have high water tables for short periods. In well-drained soils water tables are seldom above 40 inches.

The water table is the upper limit of water saturation, or the depth below which all pores in the soil are filled with water. It is measured as the depth at which water stands in a lined borehole.

Sometimes as a borehole is drilled, a water table appears and then drops as the borehole is deepened. The first table is known as a perched water table because it is not connected to the lower, true water table. Perched water tables are usually due to impervious soil layers which impede the downward movement of water, causing it to fill all the pores in a higher layer.

The Department of Agronomy has measured water tables at several sites in recent years (Fig. 1). Water tables found at each site, together with weekly and annual precipitation are presented in Figures 2 and 4 through 9. Some of the conditions affecting the water tables at the various sites are discussed in the following paragraphs. For most of the soils, other data than water table fluctuations are available through the Department of Agronomy, University of Illinois, or the Soil Conservation Service.

J. B. Fehrenbacher is Professor of Pedology; J. D. Alexander, Assistant Professor of Pedology; and G. W. Hudelson, Soil Scientist, Soil Conservation Service.

La Salle site (Fig. 2). Water tables were measured in a natural drainage sequence of loess-derived, light-colored forest soils. These included the poorly drained Traer, somewhat poorly drained Stronghurst, moderately well drained Rozetta, and well-drained Fayette. Measurements were made in two Traer soils, one in a drainageway and one in a slight depression on a higher area (Fig. 3). Traer is slowly to moderately slowly permeable; the other soils are moderately permeable.

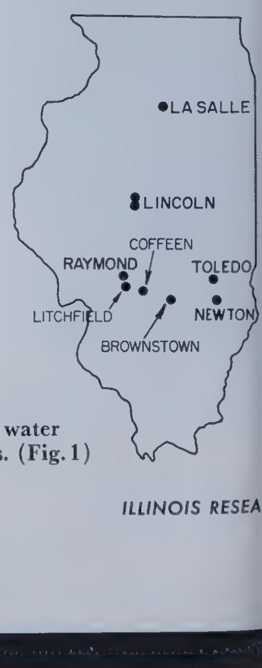
The area was in bluegrass pasture with scattered trees. There was no tile in the high depressional Traer or Stronghurst, but the drainageway Traer may have been influenced slightly by tile.

Depending on rainfall, the water table was high in the poorly and somewhat poorly drained soils in the spring of two of the five years (1962 and 1965) and was briefly as high as 45 to 50 inches in the moderately well drained Rozetta. The water table was never above 84 inches in the well-drained Fayette. In the very dry year of 1963, the water table did not rise above 60 inches in any of the soils.

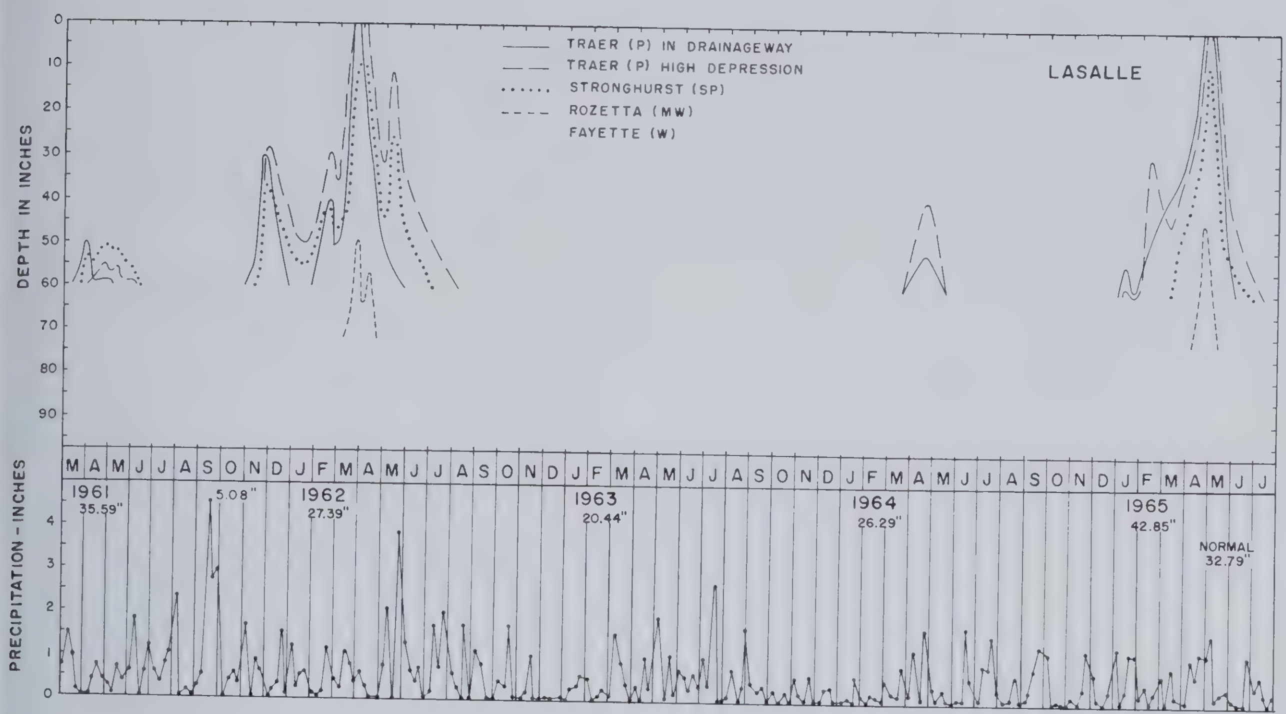
Lincoln sites. Two studies were conducted here. One was in dark, thick loess soils including poorly drained Sable, somewhat poorly drained Ipava, moderately well drained Tama, and well-drained Tama. All are moderately permeable. Relative elevations and spacings of the soils are given in Figure 3. The site was in corn and soybeans for two years of the study, and in oats for one year. The poorly an somewhat poorly drained soils ma have been very slightly influenced b distant tile lines.

In 1967, when precipitation wa unusually heavy, the water table wa between 15 and 35 inches in Sab and Ipava for one to two montl both in the spring and in the fa (Fig. 4). It rose this high for sho periods in the spring and fall in mod erately well drained Tama, but r mained below 85 inches in wel drained Tama except for a sho period in December.

In 1968, following heavy rains i the fall of 1967, water tables we high in Sable, Ipava, and mode ately well drained Tama sever times from January to August. T water table was as shallow as 6 inches in well-drained Tama f brief periods in February and Marc The side slope position of moderate well drained Tama (just below wel drained Tama on the crest of a na row ridge) may explain why t water table in this soil was as hig as in Sable and Ipava during mo of the spring and summer. Wat tables in all these soils fell below 7 inches in late summer and early fa of each year.



Location of water table studies. (Fig. 1)



Water tables and precipitation at La Salle. Letters after soil type names denote drainage, described on page 16. (Fig. 2)

The second study at the Lincoln se was conducted in dark soils rmed in 40 to 60 inches of loess er sand (Fig. 5). These soils in-uded poorly drained Sable over nd, somewhat poorly drained wndale, moderately well drained oadwell, and well-drained Broad-ll. All are moderately permeable. ell-drained Broadwell was in wheat 1967 and 1968; otherwise, corn s grown during the study. Eleva-ns and spacings of the soils are en in Figure 3.

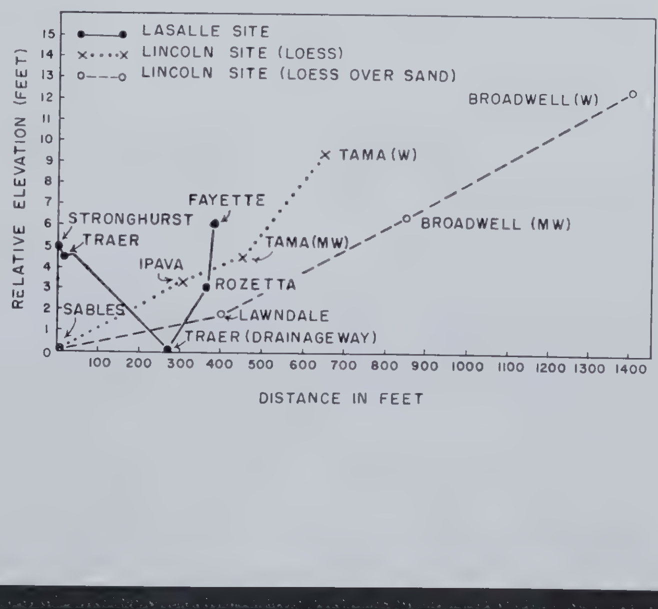
No tile lines were near the site. he underlying sandy layer may have ved as a drain to keep the water le slightly lower in the Broadwell ls than in the similar Tama soils the other Lincoln site. This layer, wever, by permitting the easy flow water from upslope soils, may ve helped to raise the water table the Lawndale and Sable over d, as compared with the Ipava Sable in thick loess.

itchfield site (Fig. 6). The study this nearly level site was in dark l moderately dark soils formed in derately thick loess. They in-ded somewhat poorly drained rrick and poorly drained Cowden and Piasa. Permeability of the three soils was moderately slow, slow, and very slow, respectively. The site was in alfalfa throughout the study. Tile did not influence water tables.

The high water use of alfalfa during a relatively long growing season tended to keep water tables low. This water use, by slowing down the recharge of the true water table, probably was a factor in the formation of perched water tables at this site. Perched tables were not very evident in Herrick and Piasa at the Raymond site or in Cowden and Piasa at Coffeen, where annual row crops were grown (Fig. 7).

The fact that the perched water table was shallower and lasted longer in Herrick than in Cowden and Piasa may be due to greater infiltration in the more permeable Herrick. In Cowden and Piasa, water infiltration may not have been enough greater than water use by the alfalfa to form long-lasting perched tables.

The recharge of the true water table, which was highest in Herrick and lowest in Piasa, is probably related to both permeability and infiltration. In all soils, water tables were below 100 inches for four to five months in the fall and early winter of each year.

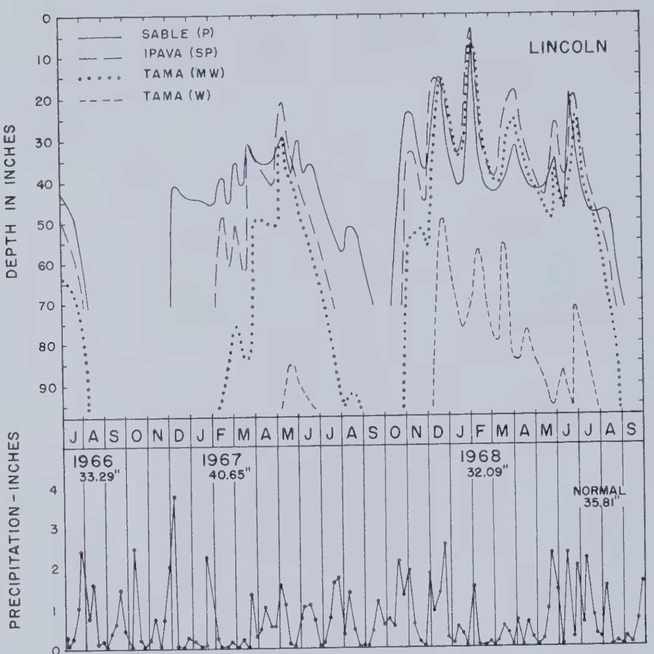


Relative elevation and spacing of soil water table studies at La Salle and Lincoln sites. (Fig. 3)

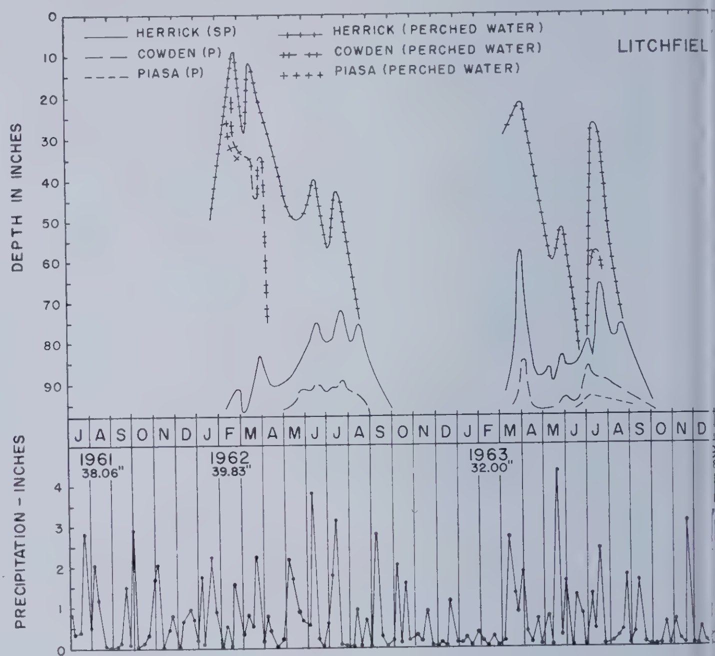
Raymond and Coffeen sites (Fig. 7). Soils were the same as at the Litchfield site. The areas were nearly level and were in row crops. Tile were not a factor in determining depth of water tables. Perched water tables were not apparent.

Below-average rainfall in 1963 and 1964 may partly account for the fact that water tables were somewhat lower than expected, especially in the spring. At Raymond, water tables were essentially the same in Herrick and Piasa. At Coffeen, water levels were slightly higher . Piasa than in Cowden. This diffe ence may be related to less cro growth and less water use on Pias

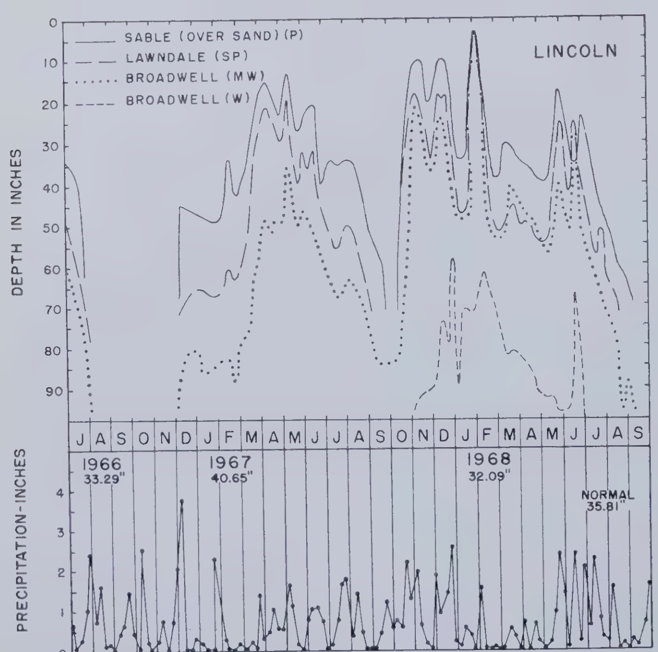
Brownstown and Toledo sit (Fig. 8). At both sites soils were th moderately dark- to light-colore



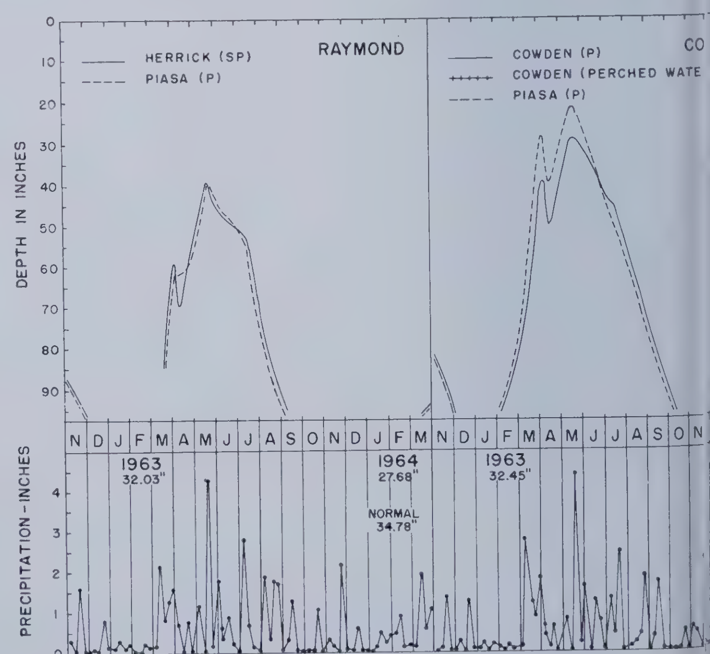
Water tables and precipitation in thick loess soils at Lincoln. Drainage is described on page 16. (Fig. 4)



Water tables and precipitation at Litchfield. Letters after soil type denote drainage, described on page 17.



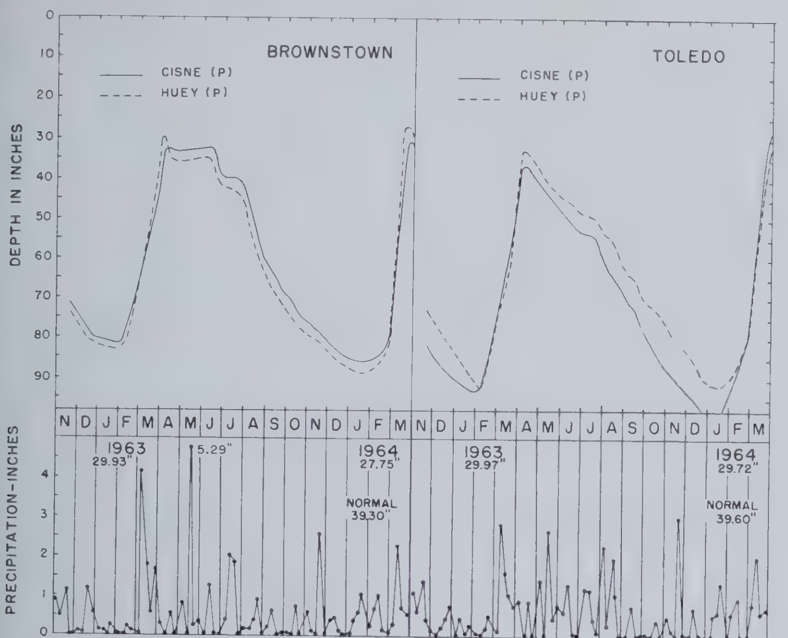
Water tables and precipitation in loess soils over sand at Lincoln. Drainage is described on page 17. (Fig. 5)



Water tables and precipitation at Raymond and Coffeen. Letters a type names denote drainage, described under "Litchfield site."

isne and Huey, which were formed n thin loess over a paleosol or older, uried soil. Cisne has a claypan B orizon and is slowly to very slowly ermeable. Huey is high in sodium nd is very slowly permeable. These tes were nearly level and were not led. They were in row crops. Low rainfall in 1963 and 1964 probably accounts for somewhat lower water tables than expected in these poorly drained soils.

Newton site (Fig. 9). Soils were nearly level, poorly drained Huey soils high in sodium. Corn was grown throughout the study.

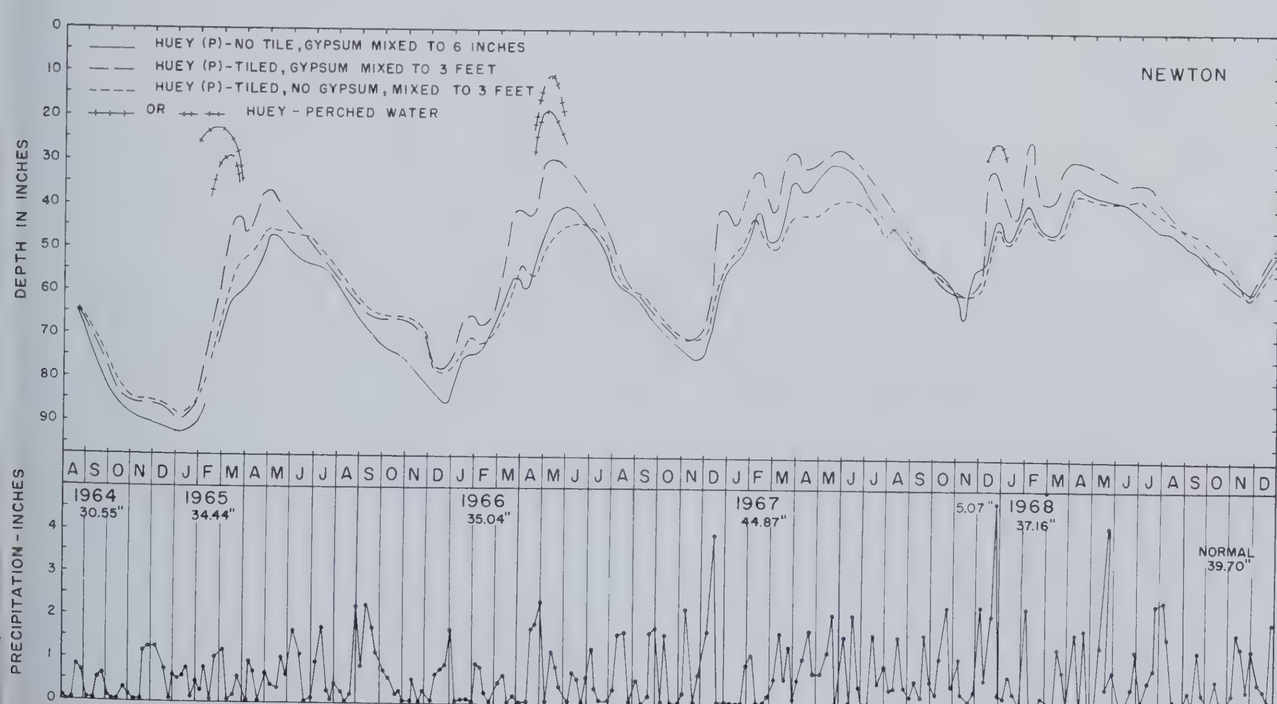


Water tables and precipitation at Brownstown and Toledo. Letters after soil type names denote drainage, described on pages 18 and 19. (Fig. 8)

The study included three plots. One plot, 30 feet wide, was not tiled, and 10.7 tons of gypsum per acre was mixed in the 6-inch plow layer. A second plot, 10 feet wide, was tiled and 27.8 tons of gypsum per acre was mixed in the top 3 feet of soil. On the third plot, which was 60 feet wide and tiled in the center, the top 3 feet was mixed without gypsum.

Water tables showed similar trends in all plots, varying from about 25 to 45 inches in spring and from 60 to 90 inches in late summer. In general, the water table was several inches higher in the 10-foot plot mixed to 3 feet with gypsum than in the other plots. Mixing the gypsum to 3 feet probably increased permeability and permitted faster and greater recharge of water both by increased infiltration and by upward moving water from below. Slight perched water tables were usually present in spring. Tile did not seem to lower water tables much in this very slowly permeable soil.

Measurements at all sites emphasize the need for adequate drainage systems to keep water tables from being too high at times in poorly and somewhat poorly drained soils.



Water tables and precipitation at Newton. Letters after soil type names denote drainage, described on page 19. (Fig. 9)

FARM BUSINESS TRENDS

PROFITS from livestock enterprises have improved markedly in recent years. Much of the improvement has resulted from a strong increase in consumer demand for meats.

"Demand" is being used here in the strict economic sense, meaning the ability and willingness of consumers to buy — in this case, the willingness to buy steaks, roasts, hamburger, pork chops, ham, bacon, and other meats.

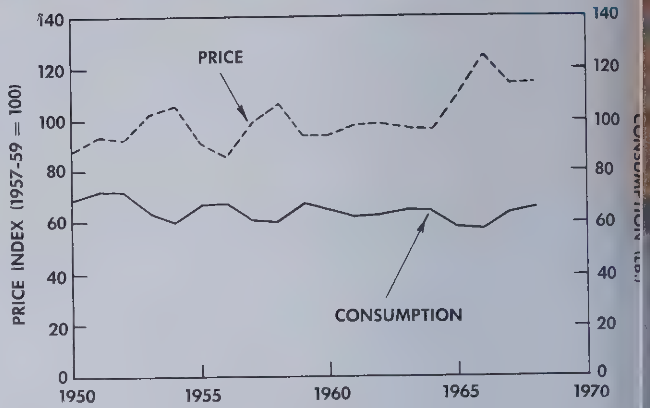
Economists consider that demand has increased when buyers either take a larger amount of a product without a change in price, or take the same amount at a higher price. Demand refers more to the amount of money spent than to the quantity purchased or to the price paid.

The demand for beef has been growing rapidly and quite steadily for many years. By contrast, the principal change in the demand for pork was a sudden and strong increase in 1966. The results of these changes are shown in the two charts.

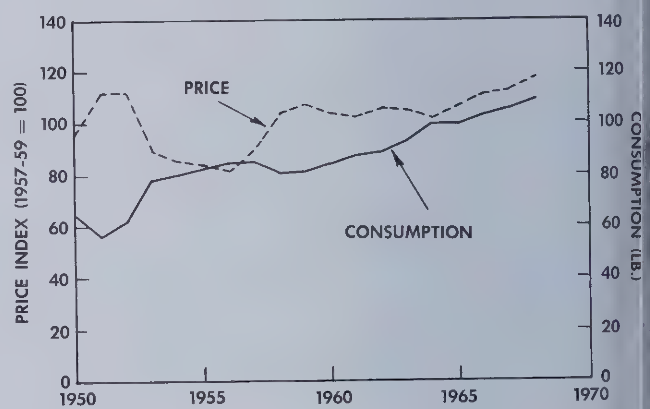
In Figure 1 the lower line shows the annual per capita consumption of pork from 1950 through 1968. The consumption of pork in any one year is determined by the amount that farmers produce that year. Thus consumption reflects the hog cycle — a four-to-five year fluctuation in the production of hogs.

The upper line shows an index of retail prices for pork each year. Consumers control prices by their willingness to pick up pork at the meat counter and to pay for it at the cash register. Although the supply of pork was about the same in 1967 and 1968 as in 1963 and 1964, consumers were willing to pay considerably higher prices during the last two years. Most of the increased spending for pork has been reflected in much better prices for hogs.

In Figure 2, the lower line shows the consumption, or supply, of beef. Despite the cycle in beef production, which runs eight or more years from peak to peak, the general trend of beef output has been strongly upward since 1950.



PORK: Price and per capita consumption, 1950-1968. Consumers are spending more for pork than in the past. (Fig. 1)



BEEF: Price and per capita consumption, 1950-1968. Consumers are buying more and paying higher prices. (Fig. 2)

The upper line is an index of retail prices of beef. Prices declined when the supply increased sharply, as would be expected. But over the entire period prices have trended upward even as the supply increased. Consumers have been willing not only to pay higher prices for beef but also to buy much larger amounts. Producers have gained by being able to sell more cattle at higher prices. — *L. H. Simerl, Professor of Agricultural Economics*

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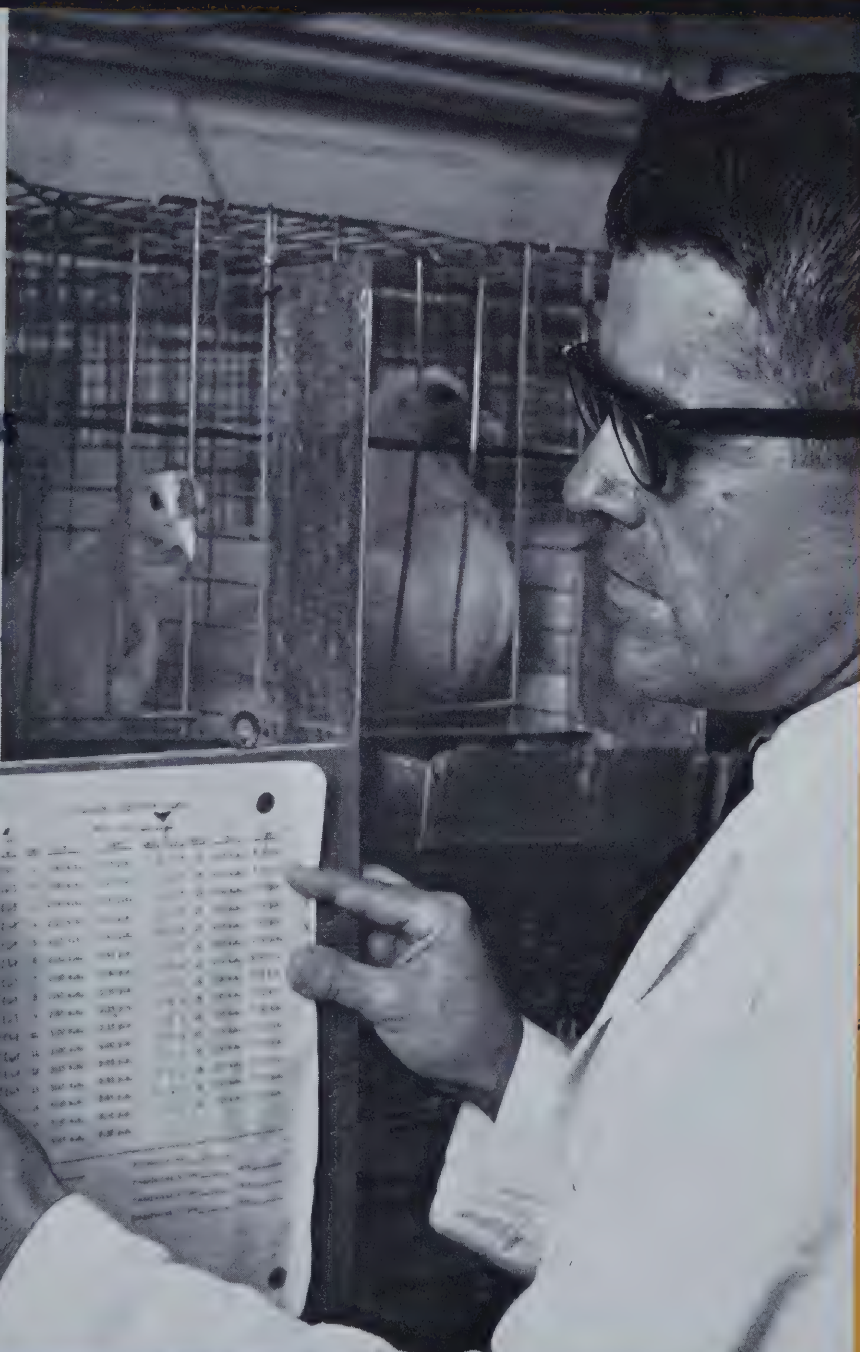
ILLINOIS RESEARCH

Illinois Agricultural Experiment Station



IN THIS ISSUE

A time clock controls day length for pullets during a study on the effects of low-protein diets (page 8).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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INSTRUMENTS FOR ADJUSTMENT TO CHANGE

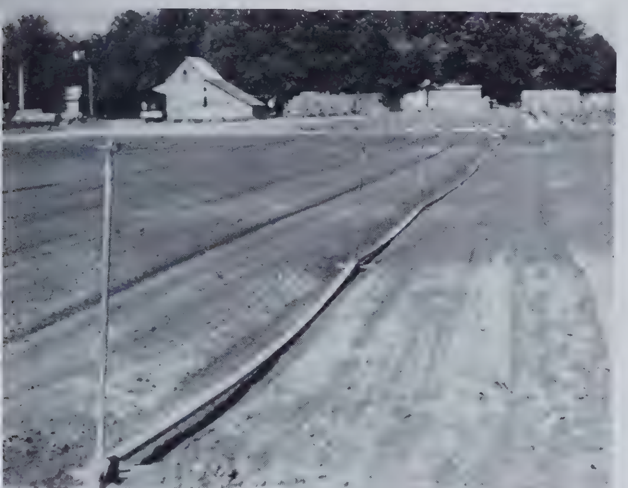
Over a century ago, Illinois contributed mightily to the susta ing American concept of higher education for the comm man. In the midst of war in 1862, President Lincoln signed the that initiated the federal-state relationship in the Land Grant u versity system. When established by the several states, the La Grant universities were to teach, among other things, agricult and the mechanic arts. This idea had been long a dream of Jo than Baldwin Turner of Jacksonville, who had been its grea single advocate. Those were days of great stress, of unaccuston change, and of social upheaval.

Again in the 1880's, after the establishment of many state La Grant colleges and universities (the University of Illinois was est lished in 1867 as the Illinois Industrial University), John Mil Gregory, first Regent of the University of Illinois, and Willard Flagg, first Secretary of the Board of Trustees, recognized tha Illinois teachers were to teach much they had to know much. T stressed that teachers of agriculture at universities must le through research if they were to teach others to improve fa productivity. Gregory and Flagg were the first to declare the n for state agricultural experiment stations and did much to prep the way for the federal Hatch Act of 1887, which authorized creation of such stations, again in a federal-state partnership.

The research of the Illinois Agricultural Experiment Stati since its modest beginnings in the latter part of the nineteenth c tury, has had a widely acknowledged beneficial influence on productivity of Illinois's agriculture and on the conservation of t potential for the needs of the twentieth century. Possibly the Exp ment Station's most important addition to the wealth of Illinois been the solid, factual information which has contributed to education, training, and development of Illinois citizens and wh has helped them to solve the problems of productive agricult Today the people of this state and nation face continuing cha and societal stress, perhaps as never before. The need for kno edge that will permit adjustment to changing conditions and survival of Illinois's agricultural industry has at no time been gre than it is now. — *G. W. Salisbury*

;olid set irrigation system.

Mechanized propelled gun system.



[and-move system.

Mechanized center pivot system.

RRIGATION CAN PAY IN ILLINOIS

)epending on Crops, Soils, and Management

ARROLL J. W. DRABLOS and FRANKLIN J. REISS

RRIGATION has been used in Illinois for many years in the production truck, flower, and other specialty ops. Now improved technology is aking it economically feasible to rigate field crops in some sections the state.

To determine the extent of irrigaon in Illinois, the Departments of gricultural Economics and Agriculral Engineering conducted a sury in the fall of 1966. County Exnsion Advisers in Agriculture sent iestionnaires to every known irritor in each county. The response to the survey was not complete, but it does provide some insight on the trends of irrigation in the state. Of 162 questionnaires returned, 148 provided complete data.

rroll J. W. Drablos is Assistant Professor of ricultural Engineering; Franklin J. Reiss is fessor of Farm Management and Land Econics, Department of Agricultural Economics.

Crops and irrigation methods

An estimated 28,000 acres of field and specialty crops were irrigated in 1966. Irrigators responding to the survey accounted for 21,444 acres. In Table 1 results of the 1966 survey are compared with results of a survey made in 1956. Corn, a favorite crop in both years, showed the greatest increase in acreage during the 10 years. Specialized crops (snap beans, other vegetables, sod, nursery items, flowers, and fruit) accounted for about 33 percent of the crops irrigated in 1956; 37 percent in 1966.

Table 2 shows the acreages of various crops irrigated by different types of systems. The mechanized systems account for 52 percent of the acreage irrigated and the hand-move systems account for about 37 percent, leaving 11 percent divided between subsurface, surface, and solid-set systems. Of the 343 irrigation systems accounted for in the survey, 187 systems, or 55 percent, were hand-move; 140 systems, or 41 percent, were mechanized. The crops with the largest number of handmove systems were corn and vegetables. Average acres per system

Table 1. — Illinois Crops Irrigated in 1956 and 1966; Acreages and Percent That Each Acreage Is of Total

Crop	1956		1966	
	Acres irrigated	Pct. of total	Acres irrigated	Pct. of total
Corn	2,823	42	12,335	58
Snap beans	0	0	3,961	18
Other vegetables	1,111	16	1,827	9
Sod	0	0	1,757	8
Soybeans	629	9	826	4
Hay and pasture	740	11	317	1
Nursery and flowers	726	11	214	1
Fruit	394	6	207	1
Other	343	5	...	...
Totals	6,766	100	21,444	100

Table 2. — Crop Acreages Irrigated by Each Type of System

Crop	Acres irrigated by each system[a]						Pct.
	Hand-move	Mechanized	Sub-surface	Surface	Solid set	Total	
Corn	3,264	7,071	1,500	500	0	12,335	58
Snap beans	695	3,186	0	0	80	3,961	18
Other vegetables	1,560	262	0	5	0	1,827	9
Sod	1,317	25	0	0	415	1,757	8
Soybeans	422	404	0	0	0	826	4
Hay and pasture	222	95	0	0	0	317	1
Nursery and flowers	200	10	0	0	4	214	1
Fruit	197	0	0	10	0	207	1
Total	7,877	11,053	1,500	515	499	21,444	100
Percent	37	52	7	2	2	100	

[a] In hand-move systems, the pipes from which sprinklers operate must be moved by hand. Mechanized systems are all those with some type of self-propulsion across or around the field, including tractor-drawn tow-line systems. In subsurface systems, water permeates into the soil from buried tile line or small open ditches. Surface systems provide water by flooding and gravity flow down or between rows. A solid set system has enough portable laterals that they don't have to be moved. The laterals are placed in the field early in the season and remain until the last irrigation. The mains and submains may be either buried or portable.

Table 3. — Irrigation Systems vs. Year Irrigation Began, 148 Irrigators[a]

Year irrigation began	Hand-move		Mechanized		Surface		Sub-surface		Total	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Before 1954	22	14.9	3	2.0	0	0	1	0.7	26	17.6
1954-58	24	16.2	10	6.8	4	2.7	0	0	38	25.7
1959-63	10	6.8	17	11.5	2	1.3	0	0	29	19.6
1964	5	3.4	4	2.7	1	0.7	1	0.6	11	7.4
1965	9	6.1	7	4.7	0	0	0	0	16	10.8
1966	2	1.3	26	17.6	0	0	0	0	28	18.9
Total	72	48.7	67	45.3	7	4.7	2	1.3	148	100

[a] Some irrigators had more than one system, but only the predominant system used by each irrigator was considered for this table.

were almost twice as much for the mechanized systems as for the hand-move systems.

Mechanization appears to be increasing in those areas of the state where labor is particularly hard to find, even though the initial cost of a mechanized system is higher than for a hand-move system. Almost two-thirds of the irrigators using hand-move systems with high labor requirements began irrigation before 1958; over 80 percent of the irrigators using a mechanized system began irrigation after 1958 (Table 3).

Power source

Internal combustion engines other than farm tractors accounted for about 65 percent of the total number of power units used. Farm tracto accounted for 23 percent; electr motors, 10 percent; and others, percent.

Nearly half (49 percent) of th power units were gasoline engine including automotive, industrial, an farm tractors; 21 percent were pov ered by LP-gas; 18 percent by dies oil; and 10 percent by electricity. possible reason why gasoline engin were the predominate source power is that the irrigators best kno how to operate and maintain su units. Also gasoline engines have lower initial cost, although fuel co are higher than for diesel engines.

Water source

Irrigation as a regular farm pra tice depends upon an adequate, d pendable, and economic supply good quality water.

A total of 162 irrigators furnish data about their source of wate Wells provided the water for 17,5 acres, or 78.4 percent of the to irrigated acreage. With 174 wells use, an average of 100.7 acres w irrigated per well. Natural strea provided the water for 7.2 percent the acreage; constructed ponds a dugouts, 6.9 percent; draina ditches, 6.4 percent; and ot sources, including natural lakes a ponds, springs, and miscellane sources, 1.1 percent.

More than half (54 percent) the wells were between 80 and 1 feet deep. One was less than 40 fe and 12 were deeper than 220 fe The diameter of 73 of the wells (percent) was 18 inches; 13 w greater than 18 inches in diamet and the rest, 6 to 18 inches.

Will irrigation pay?

As with any new technology major question about irrigation Illinois is: Will it pay? To ans this question, two others must answered: What will it cost? A what are the returns to irrigation

Costs may be classified into fi or overhead costs and opera costs. Fixed costs include inte on the investment, depreciation, taxes; and are primarily a func

of the level of investment. Average investments for two groups of farms, all using mechanized systems, are shown in Table 4.

To figure depreciation charges on these investments, a life of 50 years was assumed for wells and other water sources and 15 years on all pumps, motors, and distribution sys-ems. Interest charges of 7 percent were assessed for the remaining cost values, based on the costs when the nvestments were made. Property axes were estimated at 1.3 percent of these same values. Annual fixed costs, including depreciation, interest, and taxes, amounted to about $19 or $20 a crop acre (Table 5).

Operating costs ran to about $6 or $7, making total annual costs about $25 to $27 per crop acre. These figures can be used as break-ven costs. If returns promise to qual or exceed these amounts, then rrigation will be profitable.

Our study did not develop spe-ific data on returns, but one can ranslate the above cost figures into he yield increases necessary to cover hem. Reported yield increases on orn, for example, have exceeded the 5 to 30 bushels needed to break ven at prices of $1 a bushel. One nust be cautious, however, about sing yield increases as a sole crite-on because they will vary from ear to year and from farm to farm.

There is little doubt that irrigation as been quite profitable on farms here specialty crops, such as snap eans and cucumbers, were grown nder contracts with canning or pro-essing companies. But what about orn, soybeans, and other feed and ain crops?

The answer depends partly on the otential response of crops and soils irrigation. Very sandy soils, for ample, have a greater potential sponse to added water than do soils ith a naturally higher water-hold-g capacity. Another determining ctor is the management ability of e irrigator. He needs to carefully tegrate the added water with gher plant populations, higher fer-izer levels, and other management actices.

Table 4. — Average Irrigation Investments, 12 Grain Growers and 9 Snap Bean Growers

Investment item	Grain crops	Snap beans
Water source	$ 2,123	$ 2,268
Pump and motor	4,584	4,888
Distribution equipment	14,400	17,235
Total investment	18,984	22,122
Investment per crop A.	141	133

Table 5. — Average Annual Irrigation Costs per Crop Acre, 12 Grain Growers and 9 Snap Bean Growers

Cost item	Amounts per acre	
	Grain crops	Snap beans
Depreciation, interest, and taxes	$19.62	$18.80
Fuel, power, repairs, etc.	5.39	4.64
Labor	2.03	1.12
Total annual cost	$27.04	$24.56
Acre-in. of water	7.75	6.66
Cost per acre-in.	$ 3.49	$ 3.69

Table 6 shows the economic experience of 17 Mason County farmers who used irrigation as compared with 17 who did not use irrigation. The figures come from records that the farmers kept for the Farm Business Farm Management Service.

Some striking differences can be noted in land use, corn yields, gross value of crop production, and value of total farm production. Not all crops were irrigated, which explains the lack of any difference in wheat and soybean yields. Costs reflected the added inputs for irrigation.

Although there was no clear advantage for the irrigating farmers, average returns were great enough to cover all added costs of irrigation. On some farms irrigation did not produce enough returns to cover its costs, but on others the returns were great enough to yield a profit.

The above sentence is probably a good summary of experiences with irrigation. Where management is capable and where the response potential is greatest — either because of responsive soils or a market for specialty crops, irrigation can clearly be a profitable venture in Illinois.

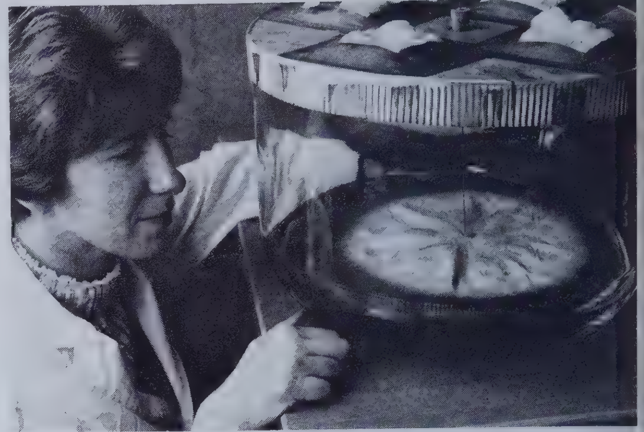
Table 6. — Size of Farm, Land Use, and Related Variables on Irrigating and Non-Irrigating Farms in Mason County (1966 and 1967 Averages)

	Irrigating farms	Non-irrigating farms
No. of farms	17	17
Av. acres per farm	523	461
Tillable acres	464	404
Soil productivity rating	44	46
Pct. of tillable land in:		
Corn and corn silage	52.9	41.5
Soybeans	19.5	24.9
Wheat and other small grains	8.8	15.7
Snap beans and other vegetables	9.0	0.1
Diverted acres and idle	4.8	5.6
Hay and pasture	5.0	12.2
Value of crop production, dollars	49,037	31,364
Per tillable acre, dollars	105.69	77.60
Crop yields, bu./A.		
Corn	107	88
Soybeans	27	30
Wheat	32	34
Value of feed fed per tillable A., dollars	14.93	15.90
Av. mo. of all labor	18.3	15.9
Investment per tillable acre, dollars		
Feed, grain, seeds, and livestock	57	53
Machinery and equipment (inc. auto)	59	29
Land and buildings	333	338
Total	449	420
Returns per tillable acre, dollars		
To unpaid labor, capital, and mgt.	47.94	48.04
To capital and mgt.	39.46	39.01
Per $100 invested	8.78	9.28
Value of farm production per tillable acre, dollars	113.95	89.38
Farm costs per tillable acre, dollars		
Soil fertility	15.91	8.34
Buildings and fence	3.82	2.89
Machinery and auto:		
Depreciation	15.52	7.29
Electricity, gas, and oil	6.21	3.72
Repairs and auto expense	6.57	4.58
Hire	1.79	1.18
Total	30.09	16.77
Labor	11.98	11.97
Taxes	4.56	5.43
Seed and crop expense	6.82	3.59
Livestock and misc.	1.32	1.37
Interest on capital	20.85	18.85
Total costs	95.35	69.21

WHY FUNGI STOP GROWING

Contrary to general belief, fungi have an innate mechanism that limits their growth

DAVID GOTTLIEB



This fungus stopped growing before it reached the sides of large culture vessel. (Fig. 1

FUNGI are one of the important causes of plant diseases. These organisms grow in the soil and on plants or animals. Some can grow on dead organic materials while others require a living host.

Until now, the generally accepted concept has been that fungi have the innate ability to grow indefinitely. It was thought that fungal growth could be limited only by (1) a lack of proper nutrients and environment, (2) toxic materials secreted by the fungi themselves, or (3) the protective mechanisms of living plants or animals on which a fungus might be growing.

Fungi do stop growing

Some recent studies on aging in fungi have forced us to reexamine the long-held concept of innate unlimited growth. For we found that fungi did stop growing under laboratory conditions.

The discovery was first made during studies of two fungi, *Rhizoctonia solani* and *Sclerotium bataticola.* The important factor in these studies was that we used round glass culture vessels that were larger than usual — 16 inches across. Both fungi stopped growing before they reached the edge of these vessels (Fig. 1). If we had used the usual small culture vessels, the phenomenon would never have been seen, because both fungi would have rapidly filled the vessels.

David Gottlieb is Professor of Plant Pathology.

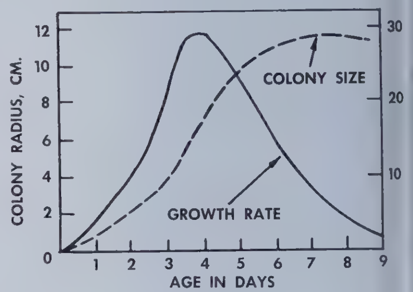
After this discovery, we studied the growth of ten fungi. Studies of *R. solani* were particularly extensive, including several strains of this species and a number of different growth media.

Typically, the fungi grew slowly at first, reached their maximum growth rate at about 4 or 5 days, then grew more slowly until growth stopped entirely between the ninth and tenth days (Fig. 2). All the fungi in the study exhibited this phenomenon to some degree. Some species grew rapidly and others very slowly, however, so that the exact times for the different growth phases varied slightly.

One fungus, *Helminthosporium turcicum,* appeared to be a maverick that did not conform to the other nine fungi; it grew all the way to the walls of the big vessels and even an inch up the walls. When we analyzed its growth day by day, however, we found that this fungus followed the same general growth pattern as the other fungi (Fig. 3). It just took longer to reach its growth peak and decline. By the time it reached the edge of the vessel, it was already well in the stage of declining growth rate. Probably if we had had a still larger culture vessel, this fungus too would have stopped growing before reaching the edge.

Limitation not in medium

To what can this inability to grow continuously be ascribed? One hypothesis is that it is due to depletion

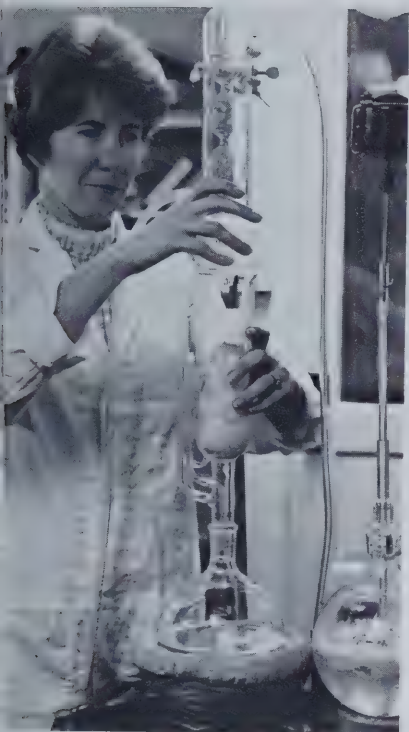


***Rhizoctonia solani* stopped growing b tween the ninth and tenth days. (Fig.**

***Helminthosporium turcicum* kept gr ing until the eleventh day. (Fig.**

of nutrients from the medium. Ts was ruled out, however, by a numb of different experiments.

First, when *R. solani* stopped gro ing, we analyzed the growth mediu for its various constituents. found that about half of the origi nutrients had been absorbed. when this medium (after removal the fungus) was reinoculated, test fungus grew as readily as in original medium. The same res



growth-limiting material is extracted om *Rhizoctonia solani.* (Fig. 4)

as obtained with a fresh medium ntaining half of the usual amount ingredients.

Another hypothesis was that, as e fungus grew, it secreted a toxin to the medium until the concentra- on of this substance became great ough to prevent further growth of e fungus. We conducted two ex- riments to test this idea.

One of the most important experi- ents was to remove the medium om the vessels each day and replace with fresh medium. This would move any toxicants and at the same ne add fresh nutrients.

In the other experiment, the owth vessel was attached to a res- voir containing fresh medium. As sh medium flowed into the growth ssel, an equivalent amount of older edium flowed out, so that a con- ntration of toxic materials would ver build up and the supply of nu- ents would not be depleted.

In both experiments, the fungus pped growing even though no ins had been allowed to accumu- e in the growth medium.

Another hypothesis disproved

Since a lack of nutrients could not explain why *R. solani* stopped growing, we next examined the nature of the fungus itself.

Fungi grow only near the tips of their hyphae, those cotton-like narrow filaments that in mass make up the body of the fungus. To test the possibility that after a time these outer cells lose the capacity to grow, we removed some of the hyphae from the outer edge of the round mass of the culture. These detached hyphae continued to grow both when they were near the mother colony and when they were placed in different flasks with fresh medium. Apparently, then, the growth stoppage was not caused by any permanent injury to the cells of the fungus.

When we cut a thin, wedge-shaped slice from the main body of the colony, no growth occurred into the empty space. This indicated that the growth inhibition is in some way related to the entire mass of the colony and is not a function of the peripheral hyphae alone.

When we examined the peripheral hyphae with an electron microscope, we could not find any structural differences between the cells of a young colony which was growing prolifically and an older colony that had already stopped growing. This result was not unexpected in view of the growth made by peripheral cells when they were taken from a colony in which growth had ceased.

Two possible hypotheses

Assuming that other fungi behave similarly to *R. solani,* it is possible that there is programmed into every fungus some mechanism which limits the size of the mass of the organism. This innate mechanism would operate independently of the limitations placed on growth by environment and availability of nutrients. The different species would vary in their maximum size, but all would have a limit.

At least two possible hypotheses can explain the operation of this mechanism. One is that the older cells near the center of a fungal colony produce a toxic material which diffuses to the younger, growing parts of the colony. As the colony grows, the ratio of old to young cells increases and thus more toxin is produced. This toxin could finally prevent the growth of the young cells.

We have extracted a material from colonies of *R. solani* which, though very impure, can prevent the growth of the same species of fungus from which it was extracted. This compound, however, is not necessarily related to the growth-limiting phenomenon which we have been observing.

The other hypothesis is based on the premise that fungal cells require hormones for growth. Most of the metabolism in fungi takes place at the very ends or growing parts of the hyphae, so it is reasonable to assume that growth hormones are made in this region of the colony. Furthermore, materials can move through the colony both from the periphery to the center and in the opposite direction. Under such conditions one can again visualize a situation in which the ratio of old to young hyphae increases as the colony grows. As this occurs there are more old hyphae through which the hormone diffuses. Finally the peripheral cells can no longer synthesize enough hormones to satisfy even their own growth needs, and all growth stops.

More research is needed to decide between these two hypotheses,. It is even possible that neither one will be verified and that a still different mechanism is responsible for growth limitation.

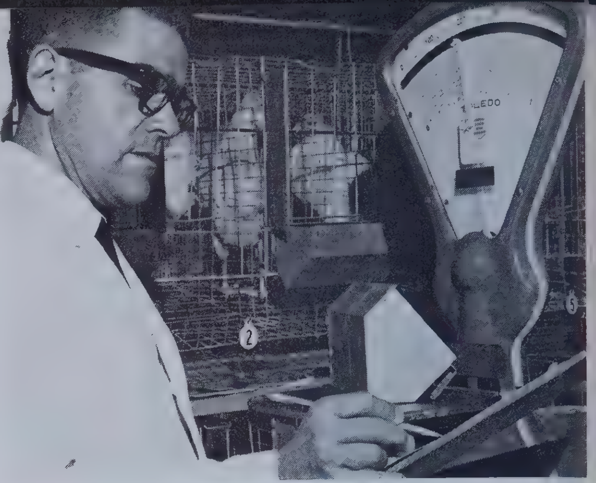
Fungi like other organisms

Finding an innate limitation to fungal growth is satisfying. It brings these organisms in line with the other plants and animals that we know. All of them have a genetically determined size limitation even though the absolute level can be regulated by other conditions.

Since our fungus acted like a body of cells similar to other organisms, fungi might serve as simple model systems to determine the cellular nature of growth limitation.

Hours of Light Affect Pullets' Response to Low-Protein Diets

D. J. BRAY



Individual feeders are weighed periodically to determine fe intake of each pullet.

POULTRYMEN often ask, "What are the symptoms of protein and amino acid deficiency in layers?"

Some answers to this question have resulted from several years of experimentation in the Department of Animal Science. We have observed the response of thousands of laying pullets to diets that were severely or moderately deficient in one or more of the essential amino acids.

Often the effect of the environment and the response of individuals have given us more information and more insight than have the average or flock responses under one set of conditions. For this and other reasons records of food intake, body weight, rate of lay, and egg weight are kept for each pullet.

Two groups of pullets

Some typical patterns of response were shown in a recent 8-week experiment with two groups of pullets. Group A pullets were 26 weeks old when the experiment started. They were "stimulighted" to induce a high rate of lay. Light was increased from 17 hours a day to 19 hours by weekly increments of 15 minutes. Group B was 40 weeks old when the experiment started and received a constant 18 hours of light.

Both groups were divided into several subgroups, each of which received a different protein level, ranging from 8 percent to 16.75 percent of the diet. All the diets were made up of corn, soybean meal, vitamins, minerals, and antibiotics.

Table 1 shows the average performance of the pullets. When the test started, the group A pullets were producing more and smaller eggs than group B.

In both groups, birds fed the 16.75-percent protein diet maintained their rates of lay, showed gains in egg weight and body weight, and maintained a high level of food intake during the 8 weeks.

At the 8-percent protein level, group A birds ate more and laid much better than group B birds, but they lost more weight, with most of the loss occurring during the first 4 weeks. In both groups, birds fed the 8-percent protein diet laid at a lower rate than the other pullets and showed no increase in egg weight. They ate less and mobilized their body reserves of the essential nutrients for making eggs.

Weekly changes

Did all the responses of the two groups occur at once, or did one thing precede another? Did every bird show the same pattern of response? Can the differences between the younger and older pullets be explained on some logical basis?

The weekly and individual observations summarized in Table 2 give us some insights into these questions.

During the first 3 weeks the egg production of the older (group B) pullets on the low-protein diet declined rapidly. Two pullets did not lay a single egg during the third week. From an average of 5.5 eggs per hen during the week preceding the assay, the average declined to only 2.3 eggs. The younger, "stimulighted" pullets produced an average of 5.0 eggs during the third week - only one less egg than in the prete period.

An interesting question is why tl younger, "stimulighted" birds mai tained a higher rate of lay and foo intake while losing more weight tha the older birds given the consta lighting. Was it a matter of age, lighting, of how long they had bee in egg production or a combinatio of these factors? Was it because t "stimulighted" birds could not sh off the egg-making machinery as rapidly? If so, why not?

Individual variations

Individual pullets on the deficie diet showed differing patterns of response with time. Pullet 1A was t only group A bird to gain weigt during the first 4 weeks. Pullets 2A and 3A continued to lay at a hi rate during the first 4 weeks, but lo considerable weight in the proce. This was associated with a low fo intake. During the second 4-we period, they lost more weight, a food intake and rate of lay fell to lo levels.

Except for a lower rate of lay the second week, bird 4A's patte was similar to that of birds 2A a 3A during the first 4 weeks. H weight and food intake stabiliz during the next 4 weeks, while eg production reached a low level.

Bird 5A demonstrated a remarkable ability to sustain a high food intake and rate of lay over a prolong period. During the final weeks, however, her body weight and food intake decreased rapidly and her ra of lay declined.

D. J. Bray is Professor of Animal Science.

Pullets 6A and 7A laid at a high ate while depleting their body veight. Then they ceased to lay for period while repleting their weight, fter which they again started to lay vell. Bird 8A appeared to be entering this cycle for the first time as the xperiment ended. In longer experiments we have observed birds that ontinue this cycle while maintaining relatively constant intake of a diet eficient in one or more essential mino acids.

Group B birds showed patterns of esponse similar to those of group A, ut the patterns were less obvious in roup B because most of the pullets vere laying very poorly after the ourth week.

ome answers for poultrymen

From observations made during nis and similar experiments, we can ive some practical suggestions for ecognizing the symptoms of protein nd amino acid deficiency:

1. Contrary to popular belief, nodern egg-type pullets with a rong genetic background for egg roduction do not get fat and quit ying for long periods when the diet deficient in essential amino acids.

2. The body weight of pullets deeases. It also becomes extremely ariable because birds differ in the tent to which they will mobilize ody tissues before they stop laying. me birds may become extremely in and morbid.

3. When pullets quit laying for ort periods, their beaks and vents ill gain color slightly.

4. A flock's food consumption will ecline with time, depending upon e severity of the deficiency.

5. The egg weight of young pults does not increase normally.

6. Rate of lay is less than excted from the normal egg producon curve.

Taken together, these trends indite a protein or amino acid defincy. One trend alone, however, ght be due to some other cause, ch as disease, breeding, or manement.

Table 1. — Performance of 26-Week-Old "Stimulighted" Pullets (Group A) and 40-Week-Old Pullets (Group B) on Two Levels of Protein

	Rate of lay, %		Egg weight, gm.		Body weight, gm.			Food intake, gm.	
	Before test	During test	Before test	During test	Before test	4 wks.	8 wks.	0-4 wks.	4-8 wks.
Group A									
8% protein	86	53	49.1	49.0	1856	1677	1634	104.6	81.2
16.75% protein	84	88	50.3	54.0	1848	1892	1885	113.6	121.5
Group B									
8% protein	79	32	52.8	52.9	1728	1661	1582	100.5	71.8
16.75% protein	78	76	54.1	56.7	1747	1850	1900	117.3	114.6

Table 2. — Individual Performances of 26-Week-Old "Stimulighted" Pullets (Group A) and 40-Week-Old Pullets (Group B) on 8-Percent Protein Diet

Pullet No.	Weekly egg production									Body weight, gm.			Food intake, gm.	
	Starting	1st wk.	2d wk.	3d wk.	4th wk.	5th wk.	6th wk.	7th wk.	8th wk.	Starting	4th wk.	8th wk.	0-4 wks.	4-8 wks.
Group A														
1A	6	5	5	5	4	3	4	2	4	1830	1896	1808	126	99
2A	7	6	5	6	3	4	2	2	0	1941	1554	1410	84	52
3A	6	5	5	5	5	3	1	2	1	1830	1446	1291	75	18
4A	5	6	3	3	3	3	2	1	2	1877	1596	1601	85	87
5A	6	7	5	6	5	4	4	2	3	1775	1611	1450	108	56
6A	7	6	5	5	3	1	0	1	5	1919	1806	1840	104	94
7A	5	6	5	5	4	0	4	5	1	1811	1610	1606	118	113
8A	6	6	6	5	4	5	4	3	0	1940	1852	2014	104	94
9A	5	7	6	5	5	5	3	1	2	1870	1699	1658	105	79
10A	7	5	5	5	5	2	3	2	2	1769	1704	1662	137	120
Av.	6.0	5.9	5.0	5.0	4.1	3.0	2.7	2.1	2.0	1856	1677	1634	104.6	81.2
Group B														
1B	4	3	0	0	2	0	0	0	0	1800	1980	1240	98	9
2B	7	7	4	3	1	3	2	1	0	1620	1450	1220	75	47
3B	6	5	4	2	4	1	2	0	0	1670	1520	1600	79	65
4B	7	5	3	2	4	1	2	2	2	1810	1750	1710	117	75
5B	4	4	6	5	3	0	0	4	1	1800	1720	1600	101	66
6B	6	4	1	0	5	0	3	0	4	1800	1730	1750	106	93
7B	6	6	4	1	0	3	1	0	1	1800	1660	1600	96	81
8B	6	3	3	4	4	3	0	0	0	1620	1600	1860	117	107
9B	6	6	4	4	3	3	3	0	1	1680	1550	1570	108	89
10B	3	3	2	2	3	3	1	1	2	1680	1650	1670	108	86
Av.	5.5	4.6	3.1	2.3	2.9	1.7	1.4	0.8	1.1	1728	1661	1582	100.5	71.8

Significance for researchers

Researchers are intrigued by the extreme variability among pullets from the same flock in their response to protein and amino acid deficiencies.

At one experiment station, chickens have been bred to have a high or low requirement for a specific essential amino acid. Further studies have been initiated to find out why these differences exist.

During the experiment described here, we were interested in the differences between the group A and group B birds fed the low-protein diet. Although differences in food intake and body weight loss were small, group A birds utilized protein much more efficiently, laying at a rate of 53 percent, as compared to only 32 percent for group B birds.

In other experiments group A birds reached their maximum egg production and maintained this production on less protein than group B birds. This conflicts with the commonly held concept that the protein level in the feed must be increased when rate of lay is high. As a result we have hypothesized that the management factor responsible for a high or low rate of lay must be considered along with rate of lay in deciding how much protein to put in the diet.

U.S. Soybeans Perform Well in India

EARL R. LENG

Higher yielding and richer in protein than the grain legumes traditionally grown in India, soybeans show great promise for solving that country's food problem

HIGH-PROTEIN grain crops are a must for solving India's pressing food problems, since a large majority of Indians do not eat meat.

Although the recent "green revolution" has enormously improved India's potential for meeting her calorie needs, a "protein gap" exists. This deficiency may actually become greater as cereal grain production expands, for improvement of grain legumes (pulses) has not kept pace with cereal improvement.

Soybean research, originated in India by staff members of the University of Illinois College of Agriculture, has shown great promise as a solution to the "protein gap" problem. The Illinois work with soybeans in India has developed as part of the USAID contract programs at Uttar Pradesh and Jawaharlal Nehru Agricultural universities.

How project developed

Planned by W. D. Buddemeier in 1964, soybean field trials were begun in India by Dr. Buddemeier and the author in 1965. Although initial results were not spectacular, they were promising enough that we imported about 60 bushels of seed for larger scale field trials in 1966.

The 1966 trials at Jabalpur (JNAU) were very disappointing because the seed arrived late and the near failure of monsoon rains resulted in very poor yields. At Pantnagar (UPAU), however, the trial plots were planted on time and produced excellent yields. The Bragg variety from the southern United States yielded over 3,000 pounds per acre, and many varieties yielded more than 2,500 pounds.

Earl R. Leng is Professor of Agronomy and Program Director, Program for International Research, Improvement and Development of Soybeans, Office of International Agricultural Programs.

Armed with this information, we proposed to USAID and the Indian government that a comprehensive research project be undertaken on soybeans. The response being favorable, a "Coordinated Research Project" was inaugurated as part of the Illinois USAID contract program. Three full-time Illinois staff members were assigned to India to conduct the project. In addition, the Indian government authorized and financed an "All-India Soybean Improvement Scheme," with staff and facilities at a number of agricultural research locations throughout India. Research under these two programs is closely coordinated.

Excellent performance

As a result of these programs, the soybean, which occupied an obscure position in India, has been brought into the limelight as a new crop of great promise. The data summarized in Table 1 illustrate the reason for this enthusiastic reception. The yield levels attained by soybeans in the 1967 and 1968 trials far exceed those of any other high-protein pulse crop grown in India. Yields of 1,000 pounds per acre have been considered reasonably good for such crops.

Somewhat surprisingly, these soybean yields were obtained with U.S. varieties adapted for the southern states and even some varieties adapted to Illinois (Clark 63, for example). All our Indian locations are farther south than the U.S. areas where these varieties are grown. Thus, the excellent performance in India went beyond our expectations, for soybeans are noted for their reaction to day length and their consequent sensitivity to latitude.

Of the varieties tested thus fa
Bragg, a Group VII maturity-ratin
type widely grown in Mississippi an
southern Arkansas, has been the mo
consistently high-yielding and th
best performer. Other varieties o
the same general maturity classifica
tion, such as Hood and Semmes, als
have done well. The later variet
Hardee, grown chiefly in souther
Georgia and northern Florida, ha
given exceptionally high yields i
some of our Indian trials. Eve
Clark 63, a Group IV variety wide
grown in southcentral Illinois, ha
yielded well in India.

All the U.S. varieties that we hav
tested in India mature rapidly. Sow
about July 1 as *kharif* (rainy season
crops, varieties such as Bragg matu
in about 120 days at Pantnagar an
105 days or less at Jabalpur. Cla
63 matures in about 105 days

Table 1. — Soybean Variety Yields 1968, at Two Locations[a]

Variety	Yield, pounds per ac	
	JNAU	UPA
Bragg	3586	29
Hood	3474	307
Semmes	3320	251
Hardee	3146	321
Clark 63	2229	16

[a] Jawaharlal Nehru Agricultural University (JNA Jabalpur, Madhya Pradesh (lat. 23° N); and U Pradesh Agricultural University (UPAU), Pantna Uttar Pradesh (lat. 29° N.).

Table 2.—Chemical Composition a Protein and Oil Production of Soybe Varieties at UPAU, 1967

Variety	Protein		Oil	
	Pct.	Lb./A.	Pct.	Lb.
Bragg	42.0	1515	22.9	8
Hampton 266	39.5	1200	23.8	7
Clark 63	41.9	1157	22.6	6

llinois and Indian economists and extension personnel agree that soybeans have great otential as high protein producers.

antnagar and 100 days or less at ıbalpur. These varieties can thus be ırvested in early October at Jabal- ır and later in October at Pantna- ır. This makes them ideally suited a two-crops-a-year rotation with heat, which is normally sown in ırly to mid-November in India.

Most traditional *kharif* crops do ɔt mature in time for the land to be epared for sowing wheat. As a re- lt, millions of acres, particularly in adhya Pradesh, now lie fallow or ow low-yield crops during the sea- n of most ample rainfall. The soy- an is an obvious solution to this oblem of efficient land use.

The nutritional importance of soy- ans, particularly in vegetarian In- a, is indicated by the chemical alysis data shown in Table 2. Tra- tional Indian pulse crops, such as am (chickpeas), mung beans, and ntils, are lower in protein percent- e than soybeans, as well as being ver yielding. In our soybean ex- riments, total protein yields per re were four to eight times as great the normal protein production of common Indian pulses. In addi- n, the soybean produces large antities of a vegetable oil with eat nutritional value.

Because of their excellent performance on the trial plots, soybeans now have been grown on enough farm-scale acreage to demonstrate that they have a real place in Indian agriculture. As a result, seed increase at Pantnagar and in several areas of Madhya Pradesh has proceeded very quickly. According to recent estimates, 12,000 to perhaps 15,000 acres of modern varieties are being grown in Uttar Pradesh and Madhya Pradesh in 1969. From less than one acre in 1965, this is truly a significant increase.

Problems of utilization

As with any new development, some problems arise with soybeans in India. The most important of these is the effective utilization of the grain.

Traditional Indian pulse crops are cooked and eaten after a relatively simple processing operation. The flavor and high oil content of soybeans, however, make them unsuited to the Indian taste if prepared in this way. Moreover, the valuable nutritional components of soybeans probably can best be utilized by separating the oil from the rest of the grain. At present in India, this operation is carried out principally for the sake of the oil, and the high-protein oil cake or meal that remains is rarely used for human food. Thus, if soybeans are to become a major crop in India, a different processing technology is needed.

One potential use of soybeans that has great significance for India is as a source of simulated milk. Soy-based, milk-like products can be manufactured by relatively simple processes. The addition of coconut oil, small amounts of dry milk solids and sugar, and a little flavoring result in a palatable, highly nutritious product. In milk-deficient India, this and similar products may bring about a significant improvement in human nutrition, particularly of weaned infants and young children. A pilot program for producing soy-based milk is planned at UPAU in the near future.

Staff members

Since early 1967, eight Illinois staff members have served in India as short-term consultants on the project (two of these each made two trips). Four agronomists — J. A. Jackobs, Theodore Hymowitz, R. M. Matsuura, and Harry Minor — have served longer tours of six months to two years in India, and another agronomy staff member, C. N. Hittle, replaced Dr. Jackobs in August, 1969. A marketing economist, B. L. Brooks, served at JNAU from July, 1967, to July, 1969, when he was replaced by Sheldon Williams.

Efforts have been made to insure close working relations with Indian personnel at the two universities and elsewhere, and with staff members at the Urbana-Champaign campus, where Folke Dovring and the author are project leaders.

Future plans for the project include intensive efforts on marketing and utilization of soybeans in India, breeding work aimed at developing still better varieties; control of insect, disease, and weed pests; and improvement of seed quality. On present evidence, it appears that this program and allied work will lead to rapid adoption of soybeans as a major crop in India.

How Much Do Soybean Yields Vary With Leaf Composition?

W. M. WALKER, T. R. PECK,
P. E. JOHNSON, and L. V. BOONE

THE RELATIONSHIP between crop yield and nutrient content of the plant or some plant part has been studied for a number of years. The leaf has usually been the plant part studied, partly because of early theories that functioning leaves controlled the plant's nutrition.

A previous report (ILLINOIS RESEARCH, Fall, 1967) described some relationships between corn yields and the levels of various elements in the corn leaf. The present study is concerned with similiar relationships for soybeans.

Topmost fully developed leaves were taken at random from soybean plants growing on experimental plots at three agronomy research fields — Brownstown, Oblong, and Toledo. The plots had received varying rates of agricultural limestone, phosphorus, and potassium. The soil type at all locations was Cisne silt loam.

Crop yields and the chemical composition of the leaves varied widely (Table 1). This variation facilitated the task of calibrating yield and leaf composition.

Since soybeans are expected to obtain their nitrogen supply largely by the fixation of atmospheric nitrogen through their nodules, the wide range in percentage of nitrogen might be surprising. Some of the experimental plots were very acid, however, and nodulation of soybean plants on these plots would probably be poor. Thus, lower nitrogen levels would be expected in the leaves. Some of the variations in micronutrient levels shown in Table 1 may be due to the effects of applied nitrogen, phosphorus, potassium, and lime.

W. M. Walker and T. R. Peck are Associate Professors of Agronomy, P. E. Johnson is Assistant Professor of Agronomy, and L. V. Boone is an Agronomist.

It is almost impossible to set leaf levels of plant nutrients as exactly as levels of applied fertilizers. What can be done is to determine the levels of observed variables on each plot and their effects on yield; then adjust all these factors to some common level. This technique is sometimes called simulation or systems analysis. It was used in preparing Table 2, as well as the chart on this page. The levels of all variables except those under study were adjusted to the mean values shown in Table 1.

In the study with corn, an association was observed between yield and leaf levels of phosphorus and zinc. The possibility of a similar relationship for soybeans was therefore investigated.

As shown in the chart, varying the level of phophorus had little effect on yields when the leaf level of zinc was 20 ppm. At a zinc leve of 60 ppm, however, yield increase with increasing levels of leaf phos phorus. These results suggest tha the critical level of phosphorus i the soybean leaf somewhat depend on the leaf level of zinc. They als suggest that high zinc levels in soy beans may be undesirable, since yielc were decreased at these levels.

Soil potassium levels are often lo on Cisne soils, resulting in low lea levels of potassium in soybean plant Under highly acid soil conditions, lea magnesium may also be low. The rela tionship between leaf potassium, lea magnesium, and soybean yields is pre sented in Table 2. At all levels c magnesium there was a yield respons to leaf potassium. This response wa greatest at high levels of magnesiun

At the lower potassium level varying the level of magnesium ha little effect on yield. But increasin magnesium did increase yields at leaf potassium level of 2.5 percent.

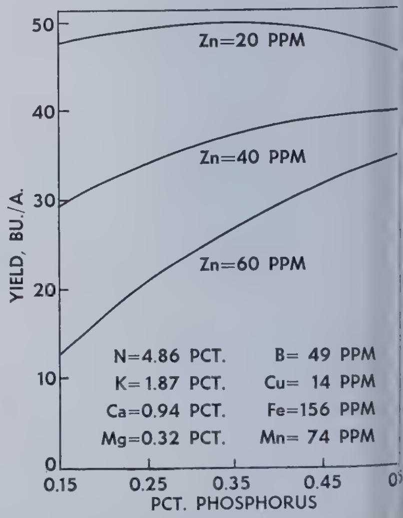
Results presented here are base on one year's data, and might b affected by varying conditions other years. They do, however, illu strate an interesting approach interpretation of plant analyses, ar suggest that the interrelationsh between plant nutrients should b recognized in the establishment "sufficient" and "deficient" nutrie levels in the soybean leaf.

Table 1. — Yields and Leaf Analysis Average of Three Experiment Fields

Variable	Mean	Range
Yield, bu./A.	36.4	12.9–49.2
Leaf analyses		
Nitrogen, pct.	4.86	3.26–6.78
Phosphorus, pct.	0.36	0.09–0.70
Potassium, pct.	1.87	0.46–2.67
Calcium, pct.	0.94	0.55–1.36
Magnesium, pct.	0.32	0.07–0.74
Boron, ppm	49	24–108
Copper, ppm	14	6– 21
Iron, ppm	156	90–268
Manganese, ppm	74	35–350
Zinc, ppm	40	18–116

Table 2. — Relationship Between Yields, Leaf K, and Leaf Mg, Average of Three Fields

Leaf K, pct.	Leaf Mg, pct.	Soybean yield, bu. per acre
0.5	.10	23.7
1.5	.10	33.2
2.5	.10	34.9
0.5	.30	21.6
1.5	.30	34.6
2.5	.30	40.0
0.5	.50	19.4
1.5	.50	36.1
2.5	.50	45.0



Expected soybean yields vary with l levels of phosphorus and zinc.

ome relationships found in nursery school children

HAND SHAPE AND PERSONALITY TRAITS

LELAND D. VAN DEN DAELE and QUEENIE B. MILLS

HE HAND, with its highly individualized ridges and lines, has been ie subject of much folklore and peculation. One early commentator rote, "A person with ulnar loops on ll fingers is clear-spirited. . . . A peron having whorls, restless." A more ecent investigator postulates that ersons with "rounder" hands tend be realistic and practical, while ersons with "longer" hands are sentive and intuitive.

Although these assertions lack presion, such speculations and others ay not be entirely naive. The genal shape of the hand and its ridges, es, and cushions vary with race, sex, d hereditary relationship. Heredity ovides a probable link between nd form and temperament.

An aspect of the relationship beeen hand form and temperament as recently examined in the Child evelopment Laboratory. Thirty-two and 4-year-old nursery school chilen (15 boys and 17 girls) served as bjects. Most of the children were iddle to upper-middle class whites th no known physical or learning sabilities.

nd measurements

Left and right handprints were tained for all the children under ndard conditions. The width of e interdigital area (the part of the lm just below the base of the finrs) was measured on each print.

Three length measurements were ide, starting from the center of the tal bracelet (the crease on the ist at the base of the palm), and tending to (1) the tip of the imb, (2) the tip of the index finr, and (3) the tip of the middle ger. Ratios were then determined tween each of these three measurents of length and the width. Since length measurements always exceeded width, the ratios were always greater than one.

Personality ratings

Two independent observers rated each child on seven personality traits: (1) dependency, or seeking the attention and help of others, (2) nurturance, or giving care and aid to others, (3) aggression, physically assaulting other persons or things, (4) control-dominance, directing the behavior and actions of others, (5) achievement, sustaining attention in self-imposed tasks, (6) avoidance, or withdrawing from social contacts, and (7) friendship, initiating cooperative activities with other children.

Previous research has suggested that these personality ratings provide relatively stable indices of individual differences. Since the two observers generally agreed in their judgments about the children, the two ratings for each child were pooled.

Correlations were calculated between the seven personality ratings and the three length-to-width ratios of the hands. Results for the left and right hands were about the same.

Relationships found

The correlations suggested that children with relatively rounder hands tended to be more dependent, more aggressive, more inclined to control others, and less achievement-striving than children with longer, thinner hands (Table 1). When the correlations for boys and girls were separated, both sex and hand ratio were found to be related to personality (Table 2). Girls with rounder hands tended to be less nuturant and more avoidant, while the opposite was suggested for boys.

Significance of results

The results imply that children with relatively round hands tend to be intrusive and demanding of attention; children with longer hands, independent and achievement-oriented.

In no sense, however, does the hand form determine the child's personality. Rather, hand form is one aspect of the biological entity which is the child. The shape of the hand is very probably related to body type, which, in other research with young children, has been shown to be related to modes of behavior. Thus, hand form may provide an economical method of assessing the relationship between behavior and physical development.

Table 1. — Correlations Between Personality Traits and Length-to-Width Ratios for Left Hand

Personality trait	Length-to-width ratios, length measured to: Thumb	Index finger	Middle finger
	Correlations		
Dependency	−.25	−.35*	−.35*
Nurturance	.27	.22	.20
Aggression	−.35*	−.36*	−.38*
Control-Dominance	−.24	−.29	−.35*
Achievement	.34*	.52**	.48**
Avoidance	−.12	−.07	.00
Friendship	.07	.10	.05

* Odds are more than 19 to 1 against a chance correlation this large.
** Odds are more than 99 to 1 against a chance correlation this large.

Table 2. — Correlations Between Two Traits and Left Hand Ratios According to Sex

Sex and personality trait	Length-to-width ratios, length measured to: Thumb	Index finger	Middle finger
Males	Correlations		
Nurturance	−.13	−.11	−.02
Avoidance	.34	.38	.34
Females			
Nurturance	.48*	.33	.20
Avoidance	−.43	−.44	−.33

* Odds are more than 19 to 1 against a chance correlation this large.

nd D. Van den Daele is Assistant Professor Child Development; Queenie B. Mills is Proor of Child Development.

Illinois Farm Income Tax Training Schools

Cooperative Extension and the Internal Revenue Service sponsor these schools for consultants who help farmers prepare their tax returns

FAY M. SIMS and C. ALLEN BOCK

Training school at Jacksonville, December, 1968.

THIS FALL and winter about 1,500 tax practitioners and consultants will bring themselves up-to-date on new income tax laws and regulations by attending Farm Income Tax Training Schools. Twenty-one schools will be held at 20 locations throughout the state between November 17 and December 16. Each school will last two days.

These schools have been held by the Cooperative Extension Service ever since 1940. Beginning in 1950, the Internal Revenue Service has joined forces with the Extension Service in presenting the schools. Revenue agents from the IRS serve as instructors.

At first the schools were held for farmers and other individual taxpayers, as well as for persons who prepare tax returns for others. Now, however, the schools are designed for tax practitioners and consultants rather than for the individual taxpayer.

This change reflects the tendency for more and more farmers to rely on tax practitioners as both the farm business and the tax laws become more complex. It is good business for a farmer to emphasize his "long suit" — the production of corn, soybeans, pork, beef, milk, or other products — and hire a competent person to help him prepare and file his income tax returns.

With the tax schools "wholesaling" accurate and up-to-date income tax information to tax practitioners, the practitioner can, in turn, "retail" this information to thousands of Illinois taxpayers. This achieves the goal of the tax schools, which is to increase the number of properly and accurately filed income tax returns.

The tax schools affect an ever-increasing number of tax returns. Tax practitioners who attended the 1960 schools reported that they had prepared 35,000 farm income tax returns for 1959. That year there were 164,000 farms in the state. Eight years later, when the number of farms had shrunk to 133,000, participants in the 1968 schools reported that they had prepared 101,000 farm income tax returns for 1967.

Practitioners who attend the schools also prepare many non-farm returns. The total number of income tax returns prepared by tax school participants more than quadrupled from 1959 (65,000 returns) to 1968 (271,000 returns).

Of the 1,487 income tax practitioners and consultants enrolled in the schools last year, 31 percent considered themselves solely as tax practitioners. The others prepared tax returns as part of other endeavors — 23 percent were accountants, 11 pe cent bookkeepers, 9 percent atto neys, and the remaining 26 perce were engaged in a variety of occ pations.

Most of the participants in t 1968 schools were experienced; percent had been preparing tax r turns for more than 10 years. Or 6 percent reported that they h not previously filed returns.

Sixty-two of the participants 1968 had been attending the t schools for more than 25 years a another 113 had been present at le 16 years. On the other hand nea half of the participants had attend for 5 years or less. Discussions b tween old and new students oft supplemented the formal teachi effort.

This year's schools will be h at Belleville, Bloomington, Carbo dale, Champaign, Decatur, DeKa Effingham, Eldorado, Freepo Galesburg, Jacksonville, Joliet, Salle-Peru, Litchfield, Macomb, M Vernon, Olney, Peoria, Springfie and Sterling. The Extension advis in each county will have compl information about these schools.

Fay M. Sims is Associate Professor of Farm Management Extension; C. Allen Bock is Assistant Professor of Agricultural Law.

.ife of Fence Posts s Prolonged by New Aethod of Treatment

·HIRTY POSTS treated in green condition by a "double-diffusion" rocess recently were examined after ey had served more than 12 years fences at the Dixon Springs Agriltural Center.

Peeled posts of elm, shortleaf pine, d willow were cold-soaked in an jueous solution of copper sulfate lue vitriol) followed by a second aking in sodium chromate. The ocess was designed to form copper romate in the wood and make it xic to decay fungi and insects. nce copper chromate is insoluble water, it would not be leached om the posts after they had been .

The copper sulfate solution was epared by dissolving 28 pounds of ystals in 37 gallons of water. The lium chromate was dissolved at rate of 28 pounds of chemical to gallons of water. The posts were ıked 48 hours in each solution.

An exchange of sap with the chem-l solution made it impractical to termine how much chemical was sorbed by the wood. Also, even en we coated the inside of our el drums with asphalt (car underıting), the copper sulfate corroded steel, causing leaks in the drum. e drums lasted only 13 days with coating and half that long when d uncoated.

After 146 months of service in ce lines, this was the condition of posts:

ıdition	Elm	Pine	Willow
nd	8	6	2
ayed but erviceable	1	1	2
ed	1	3	6

Jntreated posts of the same spelasted 2 to 4 years, or about oned as long as the treated posts.

ailure of treated posts was genly due to decay of the centers. ing the soaking period the chem-did not penetrate the posts deeply enough to insure long service. However, the copper chromate formed by the treatment protected the outside half-inch of each post from decay. This was enough to make the posts last three times as long as they would have otherwise. — *C. S. Walters*

Corn Yields Are Not Increased by Alternation of Plant Populations

"WHAT in the world is alternation?" asked a farmer looking at a sign in front of some corn plots on the Agronomy South Farm.

He was looking at an experiment testing a very simple idea for getting more light into a cornfield. In several previous experiments Illinois agronomists had shown that corn yields were improved when light levels were increased. In fact, at very high productivity levels when water and nutrients are in plentiful supply, light may be the primary environmental factor limiting corn yields with our present germ plasm.

Assuming that a farmer is planting one of the better hybrids at 24,000 plants per acre, how can he increase the light in the field? We wondered what would happen if we simply alternated high and low plant populations in adjoining rows. Perhaps enough extra light might filter through the low-population rows to allow superior production on the thickly planted rows. The combination might produce more grain than a solid uniform plant population. Even if this practice increased yields by only a bushel or so, the cost would be negligible. Too often, with advancements in agricultural technology the economic output is almost counterbalanced by input costs.

We tested this idea for two years at Urbana. In 1967 we used Pioneer 3306, a medium-late hybrid; and in 1968, DeKalb XL 45, an early variety at this latitude. The plots were overplanted and hand-thinned to the exact population desired. The fertility was high and soil moisture was maintained by irrigation in 1967 and by adequate rainfall in 1968.

Results were somewhat disappointing, as shown by the following figures:

Treatment[a]	*Yield, bu./A.* 1967	1968
Every row 24,000	181	150
Alternating single rows		
16,000 and 32,000	178	139
12,000 and 36,000	173	140
Alternating double rows		
16,000 and 32,000	166	139
12,000 and 36,000	162	136

[a] All rows 30-inch spacings. Four replications in 1967; two in 1968.

Rather than giving an increase in grain yields, the alternation row system gave slightly lower yields both years. So our simple, costless approach is not the answer to light exploitation in the corn field.

Better light or solar energy utilization remains a challenge to agronomists. One possible solution that plant breeders are working on is to change the shape of the corn plant through breeding. In the future you will be hearing of other research on this problem of providing more light to corn plants. — *J. W. Pendleton and M. E. Bauer*

Results were disappointing when alternate rows were planted at rates of 16,000 and 32,000 plants per acre.

FARM BUSINESS TRENDS

U.S. FARMERS have been losing some of their advantage in foreign trade. The value of exports still exceeds imports, but the excess has decreased in each of the past two years.

The value of agricultural exports reached an all-time high of $6,771 million in 1966-67 (year ending June 30). It had decreased to about $5,741 million by 1968-69 (Fig. 1).

Agricultural imports have been increasing in value since 1961, reaching about $4,931 million in 1968-69.

The excess of exports over competitive imports reached a high of $4,104 million in 1965-66, but this excess began to decline in 1966-67, and dropped sharply in the past two years — to $2,669 million in 1968-69.

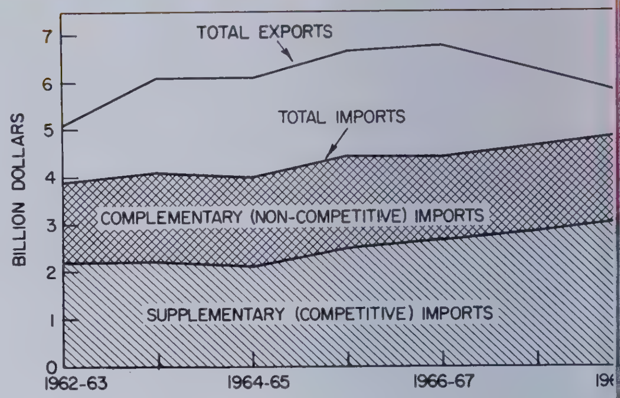
The value of exports over total imports reached a high of $2,318 million in 1966-67, but had declined to about $810 million in 1968-69.

The value of farm exports decreased primarily because of increased grain output in other important producing countries. Other factors restricting the value of our exports were (1) increasing protectionist policies in importing nations. (2) declining prices for grains, and (3) the long strike by dock workers last winter.

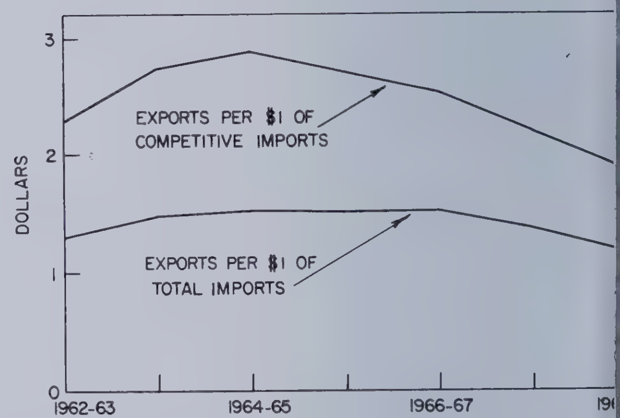
The value of agricultural imports increased largely because of the growing demand in our country for meats, fruits, vegetables, and sugar.

One simple measure of the advantage that farmers have in foreign trade is the value of exports as compared with imports. In 1964-65 for each $1 of competitive agricultural products imported there were exports worth $2.87 (Fig. 2). By last year, 1968-69, there were exports of $1.87 for each $1 of competitive imports.

The leading agricultural exports are corn and other feed grains, wheat and flour, soybeans and soybean products, animal products, tobacco, fruits and vegetables, cotton, and rice.



Value of agricultural exports and of competitive and non-c petitive imports, U. S., 1962-63 to 1968-69. (Fig



Value of agricultural exports in relation to value of agricul imports, U. S., 1962-63 to 1968-69. (Fi

The leading competitive agricultural imports meats, other animal products, fruits, vegetables nuts, and sugar. The principal non-competitive cultural product imported is coffee. Other very portant items are bananas, cocoa beans, and nat rubber. — *L. H. Simerl, Professor of Agricult Economics.*

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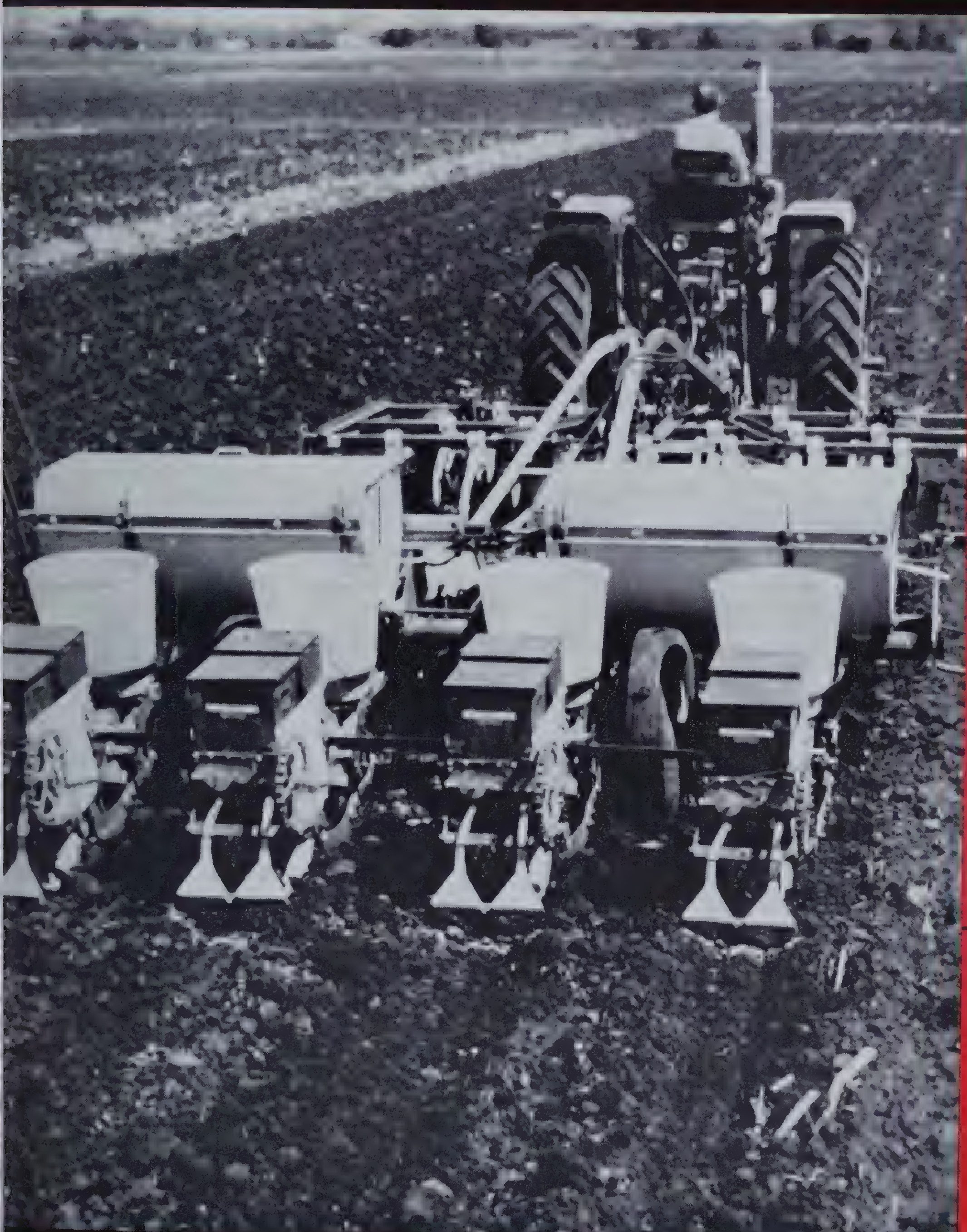
Winter, 1970

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station



IN THIS ISSUE

Does starter fertilizer increase corn yields enough to justify the extra time it requires? (page 3)

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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G. W. Salisbury . . . . Director

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Departmental representatives: Lowell Hill, Kent Mitchell, J. W. Pendleton, S. P. Mistry, K. A. Kendall, Joseph Tobias, C. S. Walters, Aiko Perry, David Dickinson, David Gottlieb, P. D. Beamer.

SURVIVAL IN THE 70's

AT THE END of each decade and the beginning of a new one, time-conscious men pause for a backward glance before facing tomorrow. Having just passed another of those benchmarks, those of us engaged in education and research are sorting through the log-jams of advice, trying to find guidelines for action in the 70's.

From past experience one suspects that man has no panaceas for his future and that human beings must continue to "cut and try" throughout the totality of existence. It is the purpose of education to teach all individuals how to avoid the pitfalls of the past; however, man is continually confronting his own with conditions never before faced by man. Some conditions have changed more in this country during the last two human generations than in all of prior history. To survive with that rate of change, man should have learned as much in those two generations as in all his previous existence. But despite the phenomenal gains in scientific and technological knowledge that have produced these new conditions, we lack the evolutionary experience necessary for our adaptation.

Many plant or animal species once on earth have disappeared in the course of time. Now, fearful for his own survival, man watches with terror the elimination of other biological species. A species is eliminated when it cannot adapt to the surrounding environment, and now man may be changing the environment faster than the rate at which biology can adapt. Forgetting that many species have passed from the earth and really knowing little about the consequences of our collective actions, we, like the miner and his canary, carry with us in our journey through time all species as danger warnings, and we recoil if one disappears in the journey.

Of course the skill lies in, and human survival depends on, heeding the right warnings. So far man has done a pretty good job of this, else why are there so many people on earth over whom collective man expresses his concern? Nevertheless, we cannot now depend on the slow process of trial and error permitted to prior generations, even of the recent past, to give directions to human endeavor. The consequences of bad judgment now may occur so fast as to be irreversible and cataclysmic. There are continuing reasons for man to learn by the speeded-up process we call research. And everywhere man is now conscious of the welfare of his environment. He'd better be — that's where he is! — *G. W. Salisbury*

CORN YIELDS
As Affected by Row Fertilizers, Planting Date, and Nitrogen Level

W. G. BRETZLAFF and L. V. BOONE

Experimental plots at the Carthage Agronomy Research Field show the effects of planting date on corn growth. (Fig. 1)

SOME ILLINOIS FARMERS are beginning to question the value of row fertilizers on corn. The "starter effect" of these fertilizers has been thought to benefit corn that is planted early in cool soils. But yield increases have been inconsistent despite the faster early growth of corn that has been fertilized at planting.

Time means money during the planting season and delays can be costly. In an effort to save time by reducing operations, the planter has been burdened with fertilizer, herbicide, and insecticide attachments. But all these attachments are defeating their own purpose. Planter size has increased to the point where a great deal of valuable time is lost during filling.

The trend toward combining all operations into one trip across the field is now being reversed. More and more farmers are trying to speed up planting by removing some of the extra attachments. Herbicides and some insecticides are often being broadcast preplant. The question arises as to whether the fertilizer attachment can also be removed from the planter, especially in view of the inconsistent results that row fertilizers have given.

W. G. Bretzlaff, Area Agronomist located in Macomb, supervises agronomy research fields at Carthage, Aledo, and Kewanee. L. V. Boone is Agronomist at Urbana.

Results of a recent three-year study can help to answer this question.

How study was conducted

The study was inaugurated in 1966 at the Carthage Agronomy Research Field in Hancock County. The field is on highly productive, dark-colored Ipava silt loam and Sable silty clay loam.

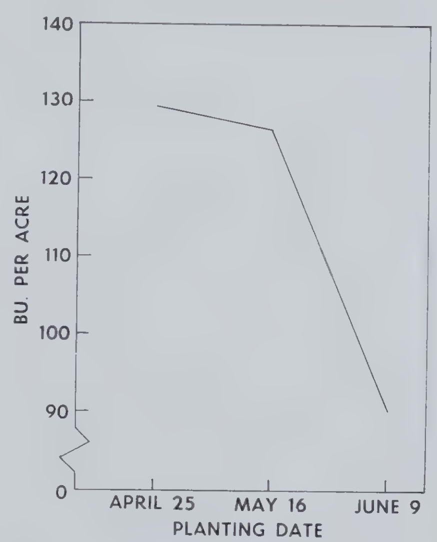
Each season corn was planted on three dates — in late April, in mid-May, and in early to mid-June. Three kinds of row fertilizer were applied on each date:

1. Pop-up (3.5-14-7 applied to the seed area through the insecticide hopper).
2. Banded (14-56-28 placed 2 inches below and 2 inches to the side of the seed).
3. A combination of pop-up with banded.

Check plots were also planted without row fertilizers. The treatments were replicated three times on each planting date.

All plots received 120-60-60 broadcast preplant. Additional 120-0-0 sidedressed was applied to one-half of each row-fertilized plot.

Nitrogen was applied as NH_4NO_3, phosphorus as 0-46-0, potassium as 0-0-60, and row fertilizer as a 7-28-14 mix. Each harvested plot consisted of three 30-inch rows 130 feet long.



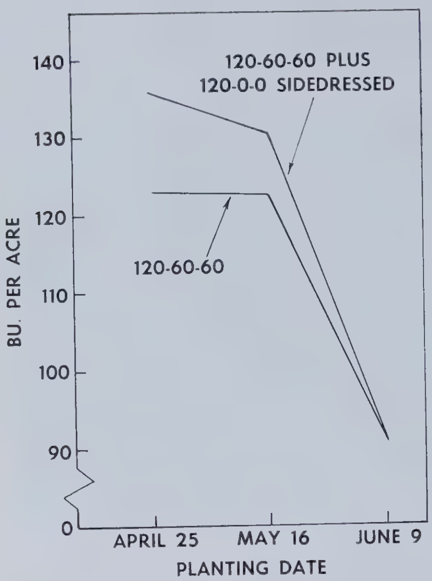
Effects of planting date on corn yield; average of two nitrogen levels and four fertilizer treatments. (Fig. 2)

Plant growth was observed visually during the growing season. The corn was machine-harvested, and yields were corrected to 15.5 percent moisture. They are reported here as No. 2 corn.

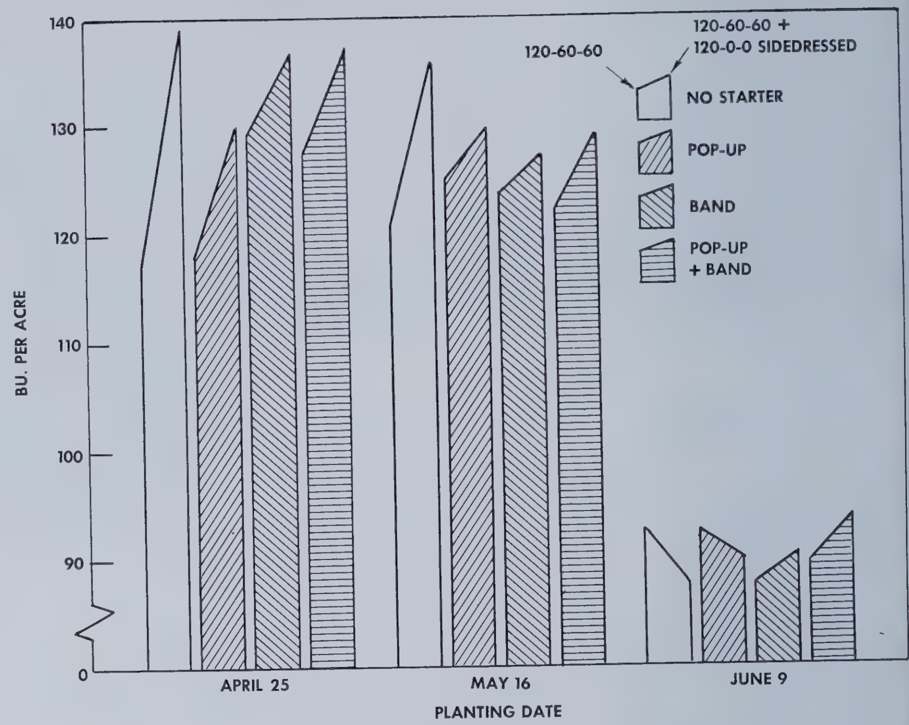
Planting date and nitrogen utilization

Previous studies have already established that early planting increases corn yields, and Figure 2 confirms this fact.

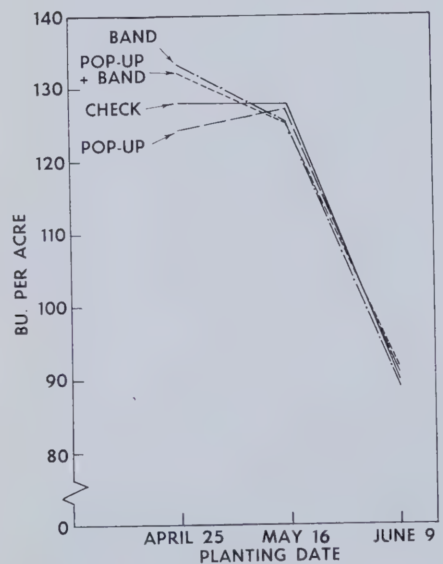
Early-planted corn utilizes the



How planting date affects corn's response to nitrogen. Data are the averages of four fertilizer treatments. (Fig. 3)



Effects of planting date, nitrogen level, and fertilizer treatment on yield. (Fig. 5)



Effects of planting date and fertilizer treatment on corn yield; average of two nitrogen levels. (Fig. 4)

spring soil moisture and the long days of early summer. The corn pollinates before the hot summer days, reducing the danger of pollination damage.

Corn planted early in the spring also responds more to nitrogen than corn planted later (Fig. 3). The extra application of 120-0-0 increased yields by 13 bushels when corn was planted on April 25. This yield advantage decreased to about 7 bushels for corn that was planted on May 16, and disappeared completely for corn planted on June 9. This indicates that the amount of supplemental nitrogen can be reduced as date of planting is delayed.

Effects of row fertilizers

Early in the growing season, plants receiving the row fertilizers were taller, greener, and sturdier looking than plants on the check plots. The difference was especially apparent on plots that had been planted in April. As the season progressed, the differences between row-fertilized and check plots became less evident. By harvest-time the effects of row treatments could not be seen at all.

Yields from the earliest planted corn were increased by the band application and the combination of band and pop-up (Fig. 4). No advantage, however, was shown for the pop-up alone. With later planting dates, none of the row fertilizers were effective.

The data in Figure 4 represent the averages of both nitrogen levels. The picture changes somewhat, however, if we separate the two levels, as has been done in Figure 5. Then it becomes evident that row fertilizers increased yields of early-planted corn only at the lower nitrogen level.

Row fertilizers not necessary

These results bring us back to the original question as to whether row fertilizers can be eliminated from the planting operation.

The answer obviously depends on the fertility level of the soil, the time of planting, and the individual farmer's situation. Where fertility is low and planting is early, row fertilizers can be expected to give good results. They provide an alternative for the farmer on rented ground who is concerned with "feeding the crop" rather than with a build-up program. If soil fertility levels are high, however, fertilizer attachments can be taken off the planter without significant yield losses.

Early plant vigor due to the starter effect of row fertilizers may make weed control easier, but this advantage loses its importance with the use of more and better herbicides.

A New Program of Education and Research in Agricultural Finance

JOHN A. HOPKIN

PROBLEMS of agricultural finance are becoming more pressing all over the world. Financial decision-making on the farm and in many farm-related businesses is often limited by outmoded methodology or inadequate data. Furthermore, the research and education necessary to serve the needs of commercial agriculture and of large agribusiness firms cannot now be departmentalized as easily as in the past.

Because of all these problems an Agricultural Finance Program was established in September, 1969, by the College of Agriculture. The purpose of the program is to stimulate and conduct research and education in agricultural finance. It will involve staff members of the Department of Agricultural Economics in the College of Agriculture and the Departments of Economics and Finance in the College of Commerce and Business Administration, as well as others both within and outside the University.

Research

Some research projects are being set up to help *explain* financial decision-making of farmers and of farm-related firms, including those that make loans to farmers. Other projects are designed to *help* farmers and decision-makers in the farm-related businesses. Finally, the research will be conducted on the public policy of all levels of government as they relate to financing the agricultural sector.

All phases of research will have both domestic and foreign dimensions. The projects are so related that progress in one will enhance progress in others.

As an example of current research, the models used to study farmers' production and marketing choices have been modified to include borrowing alternatives and constraints, as well as alternatives in managing debts. Such components are essential for helping farmers make investment choices.

As a second example of research, a new approach is being made to the study of farm-related firms. In the past they have been studied principally from the viewpoint of their responses to farmers' needs. The firms' decision problems have received less attention. Yet these problems are of critical importance for farmers as well as for the firms themselves. Many rural banks, for example, do not have the capital and paid-in surplus to grant loans of the size needed by many modern and dynamic farmers. Meeting these farmers' needs requires the participation of other lenders. The effects of alternatives open to rural banks are being studied, and this study will be expanded as the program develops.

Another topic of study will be the flow of funds that involve the agricultural sector. This study will include the various parts of the banking system, the market firms that serve farmers, and the specialized lending agencies of the Farm Credit Administration.

It is hoped that support can be developed for significant research on the public policy issues that affect agricultural finance. We are apparently entering a period of major tax reform. The various alternatives have far-reaching effects for farmers and for all farm-related groups. The same is true of monetary policies. Recent variations in interest rates, for example, have had numerous repercussions.

Research abroad is already underway, with graduate students exploring finance problems in Turkey, Thailand, and Colombia. Research projects will likely be developed in India and Sierra Leone, where the University of Illinois has major commitments for developmental programs.

Residence teaching

Interchange among the academic, farm, agribusiness, and financial communities will provide useful criteria for appraising curricula development in agricultural finance. Course offerings in agricultural finance will be modified and enriched, and some new courses may be developed. However, emphasis will be on integrating a number of courses in the Departments of Economics and Finance into the residence teaching program in agricultural finance.

A postdoctoral program will be developed to meet the needs of people in agricultural finance whose formal training requires updating or supplementation. Because research in agricultural finance is becoming increasingly sophisticated, a person who was well trained a decade ago may be ill-prepared today to explore modern research techniques.

Retraining activities

Many people in agribusiness and farm firms must make decisions on financial matters even though their primary training was not in finance. A retraining program is being developed for this group.

Retraining activities will include short seminars and longer schools. They will be built on the experience already acquired through schools, conferences, and seminars conducted by the University. These include annual bankers' and PCA credit conferences, Agricultural Industries Forums, and farm and lender workshops. The need for expanding the scope and the clientele of such retraining activities appears to be substantial.

John A. Hopkin is Professor of Agricultural Finance.

Hardwood Bark Fiber Is Used for Growing, Mulching, and Packaging of Ornamental Plants

Plants balled in composted bark for three months. From left to right: wrapped in treated burlap bag only; treated burlap plus plastic bag with small holes; treated burlap plus plastic bag with large holes; treated burlap plus plastic bag without holes.

J. B. GARTNER, D. C. SAUPE, T. R. YOCOM, R. A. KUNDROT

New ways of utilizing hardwood bark fiber are solving problems for both horticulturists and the sawmill and pulp industries.

Large amounts of hardwood bark are produced by midwestern sawmills and paper mills. Under the new antipollution laws, this bark can no longer be burned, and dumping has become a problem. The industries are therefore looking for ways of utilizing this by-product.

At the same time producers of ornamental plants have been caught in a squeeze as the costs of soil and soil amendments have risen faster than the prices of container-grown plants. Unamended soil is not an ideal growth medium for these plants, because it has poor physical characteristics. It is also heavy, adding to handling and shipping expenses. Satisfactory soil amendements such as peat, perlite, and calcined clays are expensive, and sand is very heavy. Growers of ornamental plants in containers would thus welcome a good substitute for soil and the present amendments.

According to recent experiments, hardwood bark may well prove to be such a substitute. It has also shown promise as a mulch and as a packaging material for nursery stock.

Bark as a growth medium

The possibility of using hardwood bark for container-grown ornamentals was suggested by the experiences of growers on the west coast and the southeastern states. In these areas the processed bark of redwood, pine, and fir has made an excellent soil amendment. The ground bark of these species, however, is granular, while the ground bark of hardwood species is more fibrous. Thus, the results of growing ornamentals in coniferous bark is not directly applicable to the growing of ornamentals in hardwood bark.

In 1968 experiments were begun at the University of Illinois to determine the value of hardwood bark as a soil amendment or a growing medium for container-grown ornamentals. (See Illinois Research, Fall, 1968.)

At first, bark was substituted for peat moss in the standard soil mix of ⅓ soil, ⅓ peat, and ⅓ perlite by volume. Results were so good that we eliminated perlite and increased the bark and soil to 50 percent each. Again results were good, and the bark was increased to ⅔ and the soil reduced to ⅓.

We are now using a mix of ⅔ bark and ⅓ fine sand, with soil eliminated entirely. To this mix we add 10 pounds of osmocote (a slow-release 14-14-14 fertilizer) per cubic yard, plus other treatments as indicated by results of experiments.

To date we have successfully grown several crops of geraniums, chrysanthemums, lilies, poinsettias, forsythia, taxus, junipers, barberry, cotoneaster, ribes, and pyrancantha in these hardwood bark mixes.

At first, decomposition of the bark caused a nitrogen deficiency that was difficult to overcome. The problem was partially solved when a slow-release nitrogen was added to the basic mix. Also, regular nitrogen fertilizer is applied during the growing period. Different sources of nitrogen have given different results, however, and research on this problem is continuing.

Much to our surprise, the pH of the bark leachate tended to increase after the plants had been growing in bark mixed with sand or soil for a while. This problem was corrected by eliminating lime from the basic mix and adding gypsum as a source of calcium. Minor elements, particularly magnesium, have been somewhat of a problem, especially after sand was substituted for soil. Magnesium deficiency was corrected by adding magnesium sulfate to the basic mix.

Another problem has been the bark's lack of wettability. During the first few days after planting, water must be applied frequently until the bark is thoroughly wet.

Particle size is also important. It appears that if too many fines of 1/50 inch or smaller are left in the growing medium, drainage is poorer and root sloughing may occur.

Some advantages of using bark are its good water-holding capacity, aera-

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tion, and drainage. Also, its light weight facilitates handling and shipping.

Other uses

A second potential use of hardwood bark fiber is in controlling erosion on highway cuts and fills. In experiments thus far it has compared well with conventional mulch materials. Preliminary greenhouse studies are being conducted to determine the best depth of mulch and particle size. These are important factors in the germination and establishment of grasses on exposed soil surfaces.

In another series of experiments hardwood bark is being used for packaging and artificial balling of nursery stock. Thus far the coarser materials and the composted bark have given the best results.

Type of wrap is an important factor. When solid plastic was used, a build-up of carbon dioxide injured the plants. This was overcome by perforating the plastic wrap. The optimum size and number of perforations still need to be determined.

The nutrient requirements of artificially balled material also need to be studied. The balled material definitely has different needs than the container-grown ornamentals. When the nutrients required for the ornamentals were used in the artificial balling and packaging work, we observed toxic conditions and had to begin work with lighter fertilization schedules. This work is still in progress and our latest trials are proving successful.

Studies needed

Despite the promise that hardwood bark has shown in various horticultural uses, it is still too soon to make solid recommendations. Before this can be done, we need to define and better understand the performance of hardwood bark under all conditions and its effect upon the factors affecting plant growth. We are therefore suggesting that the following areas of study be continued:

- Optimum particle size.
- Exchange capacity.
- Total nutrient content.
- Rate of decomposition and the effect of decomposition on exchange capacity, water-holding capacity, pH, and other growth factors.
- Effects of nitrogen metabolism when various sources of nitrogen are utilized.
- Effect of various species of bark on growth of ornamental plants.

PRIMA—The First Commercial Scab-Resistant Apple Variety

D. F. DAYTON and J. B. MOWRY

NO CHEMICAL sprays to control apple scab will be necessary on Prima, a new apple variety developed by research at the Illinois Agricultural Experiment Station in cooperation with the agricultural experiment stations of Purdue University (Indiana) and Rutgers University (New Jersey).

Apple scab, caused by the fungus *Venturia inaequalis,* is probably the single most serious disease of this fruit in all humid apple-producing areas of the world. Good control with chemicals is possible, but is both costly and hard to obtain. In the spring, when young leaves and fruit are most susceptible to infection, control can be very difficult because of the soft ground and the frequent rains that wash off protective fungicides. All commercial varieties except Prima are susceptible.

The apple scab resistance of Prima is a dominant genetic character inherited from *Malus floribunda,* an ornamental crabapple with ½-inch inedible fruit. By breeding, this character has been combined with the large fruit size and high dessert quality of the commercial varieties.

Prima matures in early September at Urbana, about 4 weeks ahead of Red Delicious. The attractive fruits are up to 3¼ inches in diameter. A bright medium red covers 60 to 80 percent of the fruit surface; the background is a clear yellow. The skin is smooth and glossy with practically no tendency to russet. The crisp, juicy flesh has a mildly sub-acid, rich flavor resembling that of Jonathan.

Trees are healthy, semi-spreading in shape, and moderately vigorous. Besides being resistant to apple scab, Prima has shown field resistance to fireblight and apple blotch.

Prima resulted from a cross made at the Illinois Station in 1957. The seed parent was Illinois 14-510, a scab-resistant selection two breeding generations advanced from the original source of resistance, *Malus floribunda.* The pollen parent was New Jersey 123249, a scab-susceptible selection developed at Rutgers. Tests for scab resistance of all parents were conducted at Purdue. The total parentage of the new variety is quite complicated, with five named varieties each occurring one or more times in the pedigrees of each parent. *Malus floribunda,* however, was used just once.

Prima first fruited in 1963 and was designated selection 1225-100. In 1967 it was offered to growers for advanced testing as CO-OP 5. The new variety has been grown on grafted or topworked trees at several locations in the United States and Canada. On the basis of these tests, it appears best adapted to the Midwest, but after more widespread planting, it may prove well adapted to other areas.

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Illinois Laws Affecting the Disposal of Dead Animals and Animal Wastes

H. W. HANNAH

DISPOSAL of dead animals is not an isolated problem. It is part of the problem of handling any garbage or waste containing animal matter, and this, in turn, is part of the still larger problem of solid waste disposal.

The total problem will be solved only when people insist on doing something about it. A strong movement in this direction is underway, but it has not yet touched large numbers of individuals who must somehow physically dispose of waste. Because of habit, necessity, or ignorance, we continue to use, in many instances, disposal methods that might charitably be described as primitive.

Farmers who do not want to use their own property as a dump are hard put to find a place where they can legally dispose of solid or liquid waste. And there may be legal implications even if they try to dispose of waste on their own premises.

The common law principle of nuisance has long imposed restraints on those who carelessly or intentionally interfere with the right of others to enjoy their property. In widely separated jurisdictions, courts have enjoined the creation of public health hazards and offensive smells. Many of the complaints concerned dead animals or the stench, dust, and noise of a livestock operation.

A considerable body of statutory law now supports the common law. Following is a brief digest of Illinois statutes which affect, or could affect, the disposal of dead animals and animal waste. References in parentheses are to chapters and sections of the Illinois Revised Statutes, 1967.

Statutory public nuisances

By statute, the following are public nuisances:

"To cause or suffer the carcass of any animal or any offal, filth or noisome substance to be collected, deposited or to remain in any place, to the prejudice of others.

"To throw or deposit any offal or other offensive matter, or the carcass of any dead animal in any water course, lake, pond, spring, well or common sewer, street or public highway.

"To erect . . . or use any building or other place for the exercise of any trade, employment or manufacture, which, by occasioning noxious exhalations, offensive smells or otherwise, is offensive or dangerous to the health of individuals, or of the public" (100½: 26,29).

The Fish Code of Illinois makes it unlawful to "abandon, deposit or cast any . . . insoluble materials, *including animal or vegetable material,* into the waters or upon the ice of any waters of the State, or in any place on the bank . . . where it may be washed into the waters . . ." (56: 12-7).

The Drainage Code of Illinois forbids the obstruction of drains with refuse or pollution of their waters (42: 12-7).

State and local authorities

The State Department of Public Health has authority to examine "nuisances and questions affecting the security of life and health in any locality in the State" (127: 55.08).

It may inspect any dump or site to insure compliance with a 1967 law which states that "no person shall operate or cause to be operated an open dump or site for the placing, depositing, or dumping of garbage" (111½: 461-463). This law does not apply to incinerators and sanitary land fills.

The Department also has the responsibility, under a 1967 law, of supervising "the operation and maintenance of refuse disposal sites and facilities." Development of minimum standards, registration of sites and facilities, and inspection are authorized. A Refuse Disposal Advisory Board of five members, appointed by the Governor, is advisory to the Department (111½: 471-476).

Refuse brought into the state must be disposed of at a site operating in conformity with law, or used as fill under permit from the Department of Public Works and Buildings (111½: 481-483).

Township authority. Electors at a town meeting have authority to prevent the deposit of offensive substances within the limits of a town (139: 39.15). A 1969 law (S.B.-181) defines "offensive substance" as including garbage.

It should be mentioned that townships in unzoned counties now have authority to zone (139: 301-317).

Counties. County boards may by ordinance provide for the licensing and inspection of garbage disposal areas and garbage haulers. Garbage includes "putrescible animal waste." Necessary standards, rules, and regulations may be developed and enforced, except where a person is disposing of his own garbage on his own property (34: 5401-5406). Areas controlled by municipalities are not subject to this law.

Further control can be achieved through county zoning (34: 3152-3162), the establishment of County Health Departments (111½: 20c-20c18), and establishment of public health districts (111½: 1-20.4).

Municipalities. According to law, "every city, village or incorporated town may provide such method of

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methods as shall be approved by the corporate authorities for the disposition of garbage, refuse and ashes." The law mentions such methods as land fill, incineration, and reduction to fertilizer. Salvage, fertilizer, or other things of value may be sold and the proceeds used to operate the system (24: 11-19.5).

Solid waste disposal districts are authorized under a law passed in 1969 (HB-2738).

Duties of owners

The law states that "no person caring for or owning any animal, poultry or fish that has died shall allow the body to lie about his premises. Such body shall be disposed of within 24 hours after death by cooking, burying or burning or by disposing of it, within the time, to a person licensed to so dispose of it, provided that the Department may prohibit the hauling or transportation of the body of any animal, poultry or fish which has died of a highly contagious infectious or communicable disease and order the destruction thereof in accordance with this Act" (8: 165).

Special regulations govern the disposal of swine carcasses:

"It shall be the duty of the owner or person having charge of any swine and having knowledge of, or reasonable grounds to suspect the existence among them of the disease known as 'hog cholera,' or of any contagious or infectious disease, to use all reasonable means to prevent the spread of the same, and upon its coming to his knowledge that any of such swine had died of, or been slaughtered on account of any such disease to immediately burn or bury the same to a depth of two (2) feet.

"No person shall convey upon, or along any public highway or other public grounds or any private lands, any diseased swine, or swine known to have died of, or been slaughtered on account of any contagious or infectious disease" (8: 8,9).

Disposal companies

Persons engaging "in the business of disposing of the bodies or parts of bodies of dead animals, poultry or fish" must obtain a license for that purpose from the Department of Agriculture (8: 149-167).

The Department has promulgated regulations requiring annual truck permits, maintenance of truck operators' records, control of odors, insects, and salmonella, and compliance with the Illinois Garbage Feeding Law.

Loading platforms

Operators of loading platforms for the collection of dead animals, poultry, and fish must meet standards imposed by the State Department of Agriculture and be licensed by the Department. The Department has authority to regulate and inspect. Floors must be nonabsorbent, and floors and trucks kept in a sanitary condition (111½: 186-193). The platform must be covered and in an approved location. Equipment must be disinfected, and unusable materials must be burned, buried, or spread as manure on cultivated ground not being used for pasture.

Other regulations

Locker plants and food processing plants. Operators of such plants must promptly remove "waste or offal incident to the cleaning, storing, or preparation of any food for storage," and dispose of this material in a sanitary manner (56½: 93.27).

Garbage feeding. No garbage may be fed to swine except that a person may feed his own garbage to his own swine if the garbage contains no meat (HB-1122).

Dumping garbage. It is unlawful to dump garbage on the property of another without consent; or to dump it within the boundaries of any municipality except his own, unless there is a joint collection and disposal contract with another municipality. A 1-mile limit applies (100½: 27,28).

Littering highways. It is against the law "to deposit on a public highway weeds, trash, garbage or other offensive matter . . ." (121: 9-121). A similar law applies to toll highways (121: 314a 47½).

What is needed

Under existing Illinois law, it is possible to achieve safer, faster, and more nuisance-free disposal of all solid wastes, including dead animals and animal waste. The following, however, is necessary:

- More planning, based on accurate information about the nature and amount of waste.
- Better enforcement.
- Additional regulatory requirements by the State Departments of Agriculture and Public Health. New regulations should be imposed only after thorough consideration and an opportunity for interested parties to be heard.
- Development of effective ordinances by counties, townships, municipalities, and public health districts, as authorized by law.
- Use of the new law permitting organization of solid waste disposal districts.

The need for information and education is apparent. What we do with our waste depends ultimately upon how we balance our values. In a report prepared by the Office of Science and Technology and submitted to the President in January, 1969, we find this statement:

"Effective management of environmental quality depends on the development of a broad sense of economic and social responsibility and an increased awareness of the short-run and long-run effects of pollutants. Socioeconomic inquiry into environmental deterioration establishes the basis for communication and reconciliation among different interest groups, for identification of alternatives, and for choosing the best alternative to enhance the environment in terms of human needs and desires, costs, time, and place."

Current methods of waste disposal require land as a repository. Other and better disposal methods must be found. Certainly it is possible to develop economic ways of re-using much solid waste, and of converting that which is not reusable into a less objectionable waste.

What Controls Ripening of Tomato Fruits?

Hormones manufactured by the fruit appear to have more effect than changes in respiratory rate

D. M. PHARR, J. P. McCOLLUM, and A. A. KATTAN

When more is known about regulating the metabolism of fruits and vegetables, it may become possible to turn the ripening process "on" and "off" at will. Such a program would prolong commercial storage life while maintaining high quality for the consumer.

The respiratory rate of fruits and vegetables is widely believed to play a major role in ripening. According to recent experiments with tomatoes, however, the respiratory rate may be less important in the control of ripening than is the action of hormones produced by the fruit.

Respiration and ripening

As the tomato fruit begins to ripen, its respiratory rate increases rather dramatically and then declines. This pattern of respiration is known as the climacteric. It occurs in many ripening fruits, whether they have been picked or not. Cold storage conditions which retard ripening also suppress the climacteric. The simultaneous occurrence of ripening and climacteric has been an argument for the theory that the rise in respiration controls ripening.

To determine whether the climacteric is indeed necessary for the ripening of tomatoes, an experiment was conducted with Roma tomato fruits. The fruits were harvested at two stages of maturation — mature green and after inception of red color. Bulk samples were stored in gallon jars at two temperatures — 16° C. and 24° C. Air was passed through the jars at rates of either 10 or 40 milliliters a minute.

Respiration rates were measured daily. Fruit samples were removed from storage after 4, 8, 12, and 16 days to determine fruit color and firmness. The experiment was replicated twice.

Fruit color was expressed as the a/b ratio obtained on a fruit macerate by means of the Gardner Color Difference Meter. The higher the ratio, the redder the fruit. Values for fruit firmness were determined by using the Asco Firmness Meter. High values indicate softness. Carbon dioxide evolved by the fruits was measured by gas chromatography.

As can be seen from the table below, both air flow velocity and temperature were very strong determinants of respiratory rate. They were not, however, interactive in their effects on either respiration, fruit color, or firmness.

Respiration was lower at 16° C. than at 24° C. Color development was also lower and fruits were firmer at the lower temperature. These observations were consistent with the expected slower ripening rate at 16° C.

Lowering the respiration rate, however, does not always lower ripening rate. Respiration at the rate of 10 milliliters per minute was only half as great as at 40 milliliters. Yet fruit color and firmness were not affected by the changes in air flow treatments.

The time course of respiration, color change, and firmness loss with the two air flow treatments is shown in Figure 1. The data represent the average behavior of both temperatures.

Fruits which were harvested after the inception of red color were undergoing the climateric at the time of harvest. Poor aeration strongly reduced the magnitude of this respiration. The climacteric was nearly absent in mature green fruits held at the lower air flow rate, but developed strongly at the higher rate.

Despite the very strong effects of air flow velocity on the climacteric, ripening as measured by changes in color and firmness was not affected by aeration treatment. Thus, the climacteric rise in respiration can be greatly reduced without affecting such ripening changes as softening and color development. These results indicate that the climacteric has been overrated as a process which controls ripening.

Hormones and enzymes

For a fuller explanation of the ripening process, we are investigating the roles of some hormones and enzymes formed by tomato fruits. One such hormone is ethylene gas (C_2H_4). It is produced in relatively large quantities by ripening fruits and in much smaller amounts by immature fruits. When extra amounts of C_2H_4

Effects of Air Flow Velocity and Temperature on Respiration, Color Development, and Firmness of Ripening Tomato Fruits

	Respiration, ml. CO_2/kg./hr.	Fruit color, a/b ratio	Firmness, Asco units
Air flow rate[a]			
10 ml./min.	7.74	0.88	4.3
40 ml./min.	14.06	0.87	4.5
LSD @ 5%[b]	0.22	N.S.[c]	N.S.[c]
Storage temp.[d]			
16° C.	9.28	0.58	3.7
24° C.	12.52	1.16	5.1
LSD @ 5%[b]	0.22	0.10	0.5

[a] Data are the average of both temperatures.
[b] LSD — least significant difference.
[c] N.S. — not statistically significant.
[d] Data are the average of both air flow rates.

D. M. Pharr is Research Assistant in Horticulture, and J. P. McCollum is Professor of Horticulture. The report on respiration and ripening is based on a graduate study done by Mr. Pharr at the University of Arkansas, under the direction of A. A. Kattan, Head of the Department of Food Science at that institution.

are supplied to green tomato fruits harvested after completion of growth, ripening is accelerated. It has therefore been suggested that C_2H_4 is a natural hormone which initiates ripening.

Fruits that have been harvested while still growing do not respond to applications of C_2H_4 nearly as quickly as fruits that are already grown. The hypothesis was advanced that this delayed reaction might be due to indole-3-acetic acid (IAA), another plant hormone, which is relatively abundant in young growing tissue.

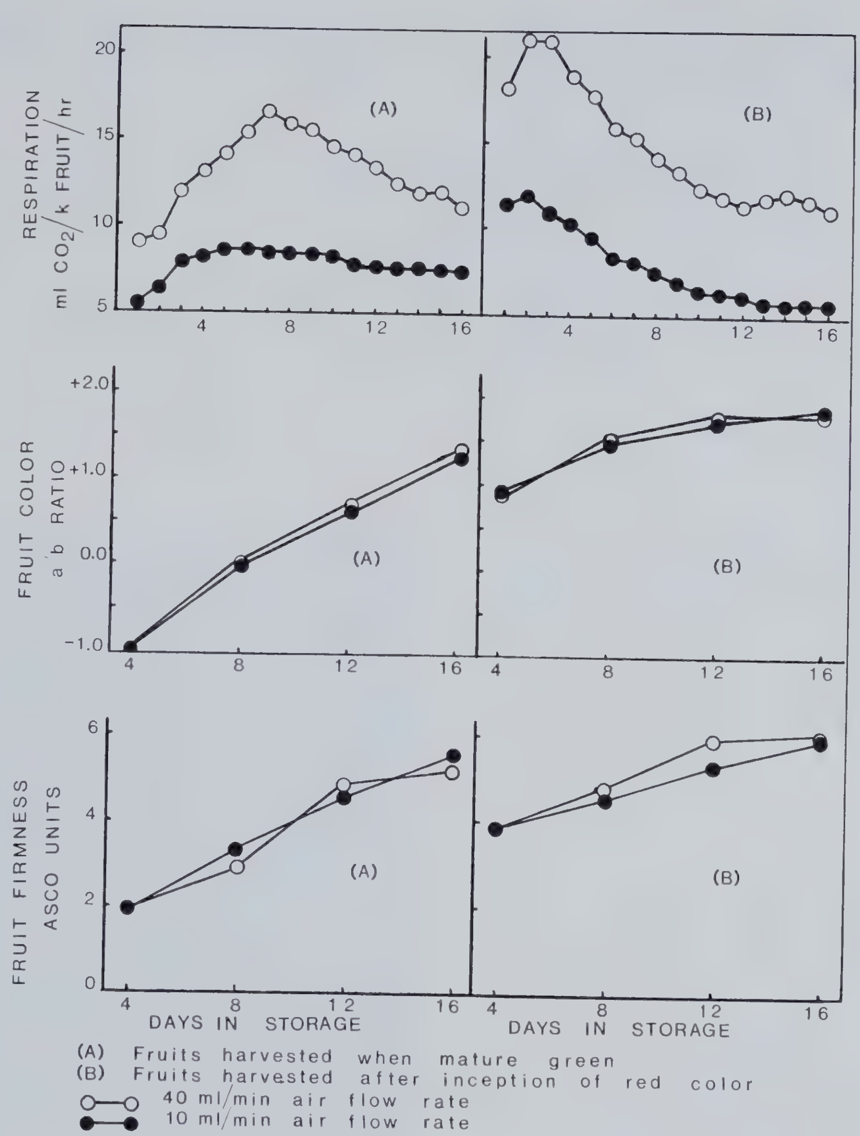
For a test of this theory, tomato fruits were harvested when mature green, and segments about 1 centimeter in diameter were cut from the outer pericarp. Some of the segments were soaked in IAA solutions for 30 minutes while others were soaked in distilled water. Segments from each soak treatment were transferred to highly humidified glass containers which were supplied with either air or air enriched with 100 ppm of C_2H_4.

At the beginning of the experiment and at the end of 5 days, segments were extracted with a hexane:acetone mixture. The lycopene, or red pigment, content of the extracts was determined with a spectrophotometer.

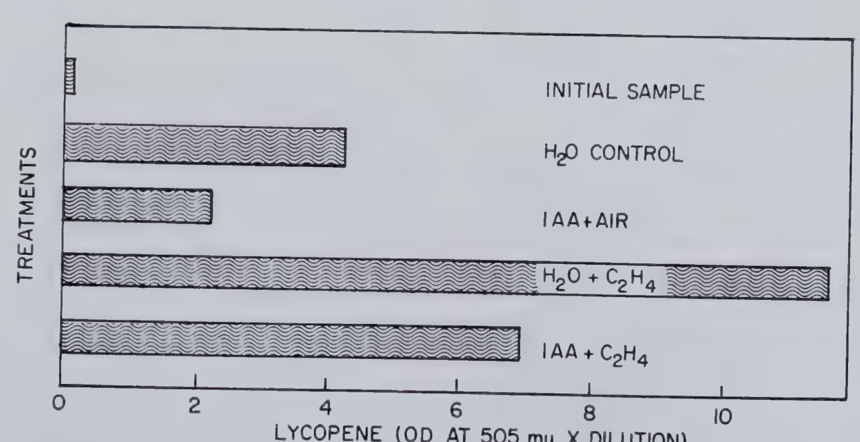
Results indicate that IAA may indeed inhibit the response of young fruits to C_2H_4 (Fig. 2). While C_2H_4 stimulated lycopene development, IAA reduced this development, both in fruit segments that had been treated with C_2H_4 and in untreated segments.

In parallel experiments we have found that actinomycin-D, which inhibits the synthesis of ribonucleic acid (RNA), also stops lycopene development. Further, C_2H_4 does not stimulate lycopene development when RNA synthesis is blocked.

We are also interested in the cellulase enzyme, which hydrolyzes cellulose and is potentially important in causing the fruit to soften. Cellulase activity was found to be almost 10 times as great in ripe fruits as in green fruits. The effects of IAA and C_2H_4 on cellulase activity are among the topics that we hope to study in the future.



Time course of respiration, color development, and firmness loss of stored tomato fruits as affected by air flow and stage of maturity at harvest. (Fig. 1)



Effects of indole-3-acetic acid and ethylene gas, alone and in combination, on lycopene development in young fruit. (Fig. 2)

Grain Stirring in a Small-Scale Bin

Tests of a vertical stirring auger indicate that grain can be thoroughly mixed if rotating speed is fast enough and traverse speed is slow enough

GLENN E. HALL and HAROLD H. BEATY

GRAIN-STIRRING devices have been used for several years in bin drying systems. These devices are claimed to speed up drying, eliminate hot spots (usually where fines collected during bin loading), and blend the grain for a more uniform moisture content. During stirring, the grain is loosened, so that less static pressure is required to force air through the grain and the volume of air flow is increased.

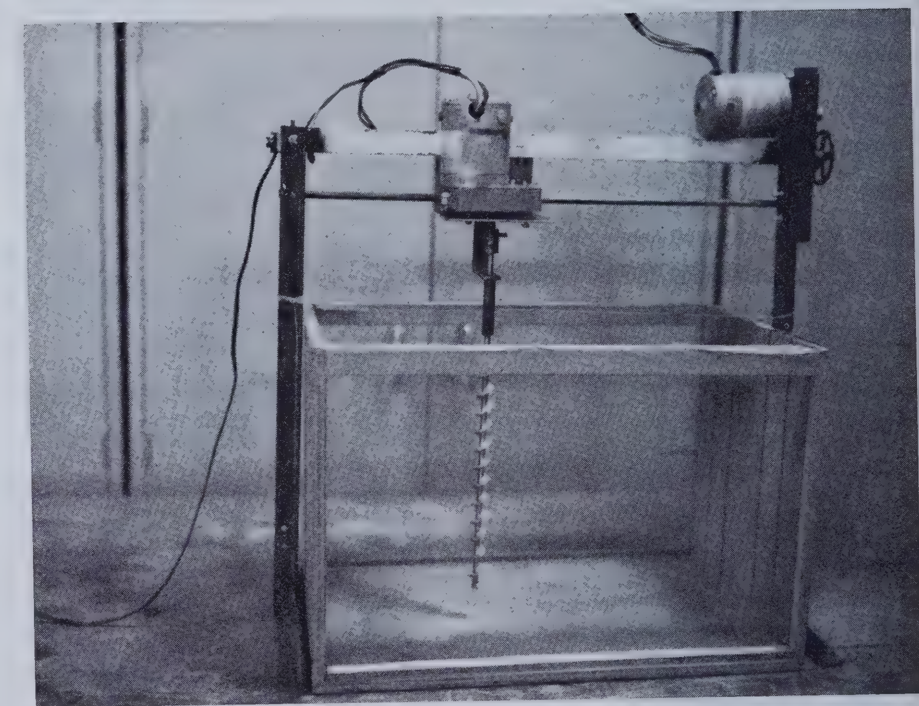
Kinds of stirring device

One type of stirring device consists of one or more 2-inch diameter vertical augers driven by electric motors. The rotating augers cycle around the bin in a definite pattern, tending to lift the grain from the bottom of the bin to the top. As the drier grain, which has been near the incoming drying air, is raised to the top, the wetter grain tends to move toward the bottom of the bin.

Another type of stirring device utilizes a sweep auger which removes grain from the drying floor. A vertical enclosed auger then elevates the grain to the top of the bin and spreads it evenly over the top of the grain mass.

Model bin

An experiment was recently conducted to determine the mixing and blending effect of a vertical stirring auger. A grain-stirring model was designed that would simulate the action of the auger in a corn bin. The model bin (Fig. 1) was 19 inches long, 12 inches wide, and 12 inches deep. A single full-pitch auger having a ¾-inch diameter and a ⅜-inch shaft was used to stir the grain (wheat was used instead of corn).



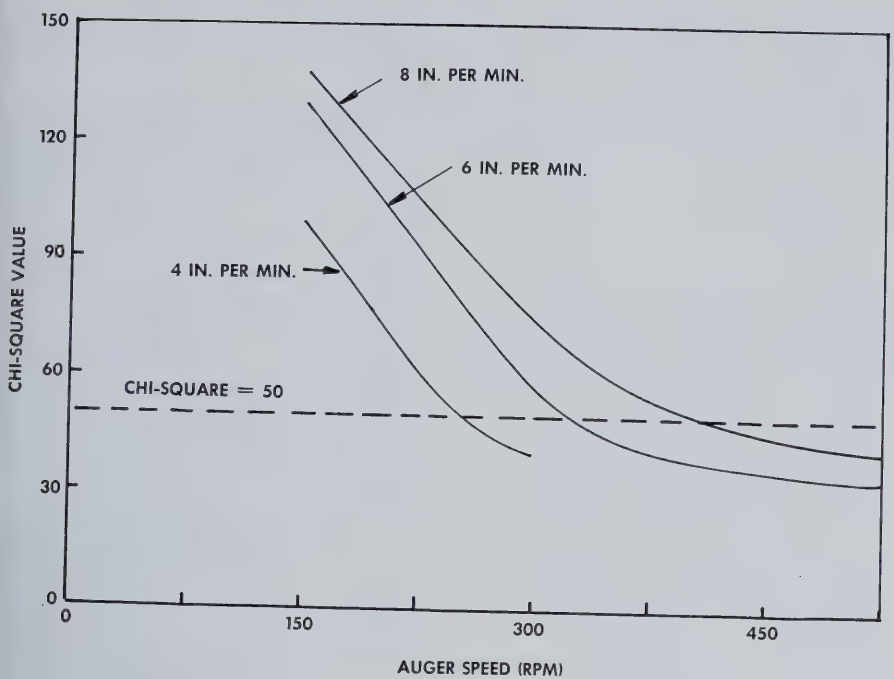
Model bin used in grain-stirring experiments. (Fig. 1)

Motors with variable speeds turned the auger and moved it across the model bin. Four auger speeds were tried: 150, 225, 300, and 525 rpm. Each auger speed was combined with three traverse speeds — 4, 6, and 8 inches per minute. After each test, 36 grain samples were collected at specified locations by use of a small grain probe.

For most of the tests, wheat with a moisture content of 21 percent was dyed red or blue, and a layer of this wheat was placed on top of an equal amount of 14-percent wheat in the model bin. Dyeing the wet wheat made it possible to determine the number of wet and dry kernels in each sample.

A small model bin was used for this initial study because it permitted greater flexibility in testing various

Glenn E. Hall is Assistant Professor of Agricultural Engineering; Harold H. Beaty is Professor of Agricultural Engineering.



Effects of auger speeds (rpm) and traverse speeds (inches per minute) on grain mixing. Grain is considered thoroughly mixed when chi-square value is near 50. (Fig. 2)

traverse and auger speeds. Large amounts of both grain and time would be needed to analyze the effects of various speeds in a full-size grain bin. It is also difficult to obtain large quantities of grain with the desired moisture contents. Another advantage of the model bin was that it provided the opportunity to perfect the sampling and analyzing techniques before dealing with large quantities of grain.

Mixing of grain

Tests with a rotating auger in a fixed location showed that, if the auger is given enough time, the layers of grain within its zone of influence will eventually be equally blended. Also, when the auger moves through the bin, it will thoroughly blend all the grain in its path, provided the rotating speed of the auger is fast enough and the traverse speed is slow enough.

In a truly blended bin, each of the 36 grain samples will contain equal numbers of wet and dry kernels (50W-50D). One difficult question is how much mixing variation one can permit and still have a blended sample for all practical considerations. How much less desirable, for example, is a mix of 40 percent wet and 60 percent dry (40W-60D) kernels than a mix of 50W-50D?

Pending the answer to this question, we aimed for as thorough a mix as possible. To determine whether a model bin of grain was blended satisfactorily, we used a chi-square test. This test related the number of wet and dry kernels in each sample to the number that would be in the sample if the bin of grain were perfectly blended. In a blended bin — that is, with each of the 36 samples containing close to a 50W-50D mix — the chi-square value would be 50 or less.

Figure 2 shows the chi-square values when various combinations of rotational and traverse speeds were used to mix the wet and dry grain. At each combination of speeds, the auger went back and forth across the length of the bin in 14 adjacent paths. This meant that the auger passed through all the grain once, with no space between the stirring paths.

As can be seen in the chart, an auger speed of 300 rpm was great enough to blend the grain when the traverse speed was 4 inches per minute. Increasing the traverse speed to 6 inches per minute raised the chi-square value to about 55, which probably represents thorough enough blending for practical purposes.

In another experiment, the auger was set so that it traversed the length of the bin in paths 3 inches apart, making a total of four traverse paths at 6 inches per minute and 300 rpm, for each mixing cycle. The auger was run for five cycles, following the same traverse paths during the last four cycles as during the first one.

After each mixing cycle, samples were collected at points halfway between the traverse paths, and the chi-square values were calculated, with the following results:

Mixing cycle	*Chi-square value*
1	628
2	270
3	110
4	51
5	30

It can be seen from these figures that the grain in the model bin was mixed after about four mixing cycles, or 16 traverse trips across the model bin. The chi-square value at that time was very close to 50. It was also close to the value obtained for the 6 ipm-300 rpm combination when 14 adjacent mixing paths were used.

According to the results of this study, the traverse paths of the auger should be adjacent (or spaced apart and repeated several times) to achieve true blending of the wet and dry layers of grain. Although air was not forced through the grain to measure the increased air flow due to stirring, it was obvious that the grain was loosened during stirring, since the level of grain in the bin increased. This would result in a greater air flow during drying and faster drying.

Further tests planned

Results from this study are being used to design an experiment for determining the blending which occurs in full-size grain bins when a stirring device is used.

Ammonium Chloride Helps To Control Parturient Paresis in the Dairy Cow

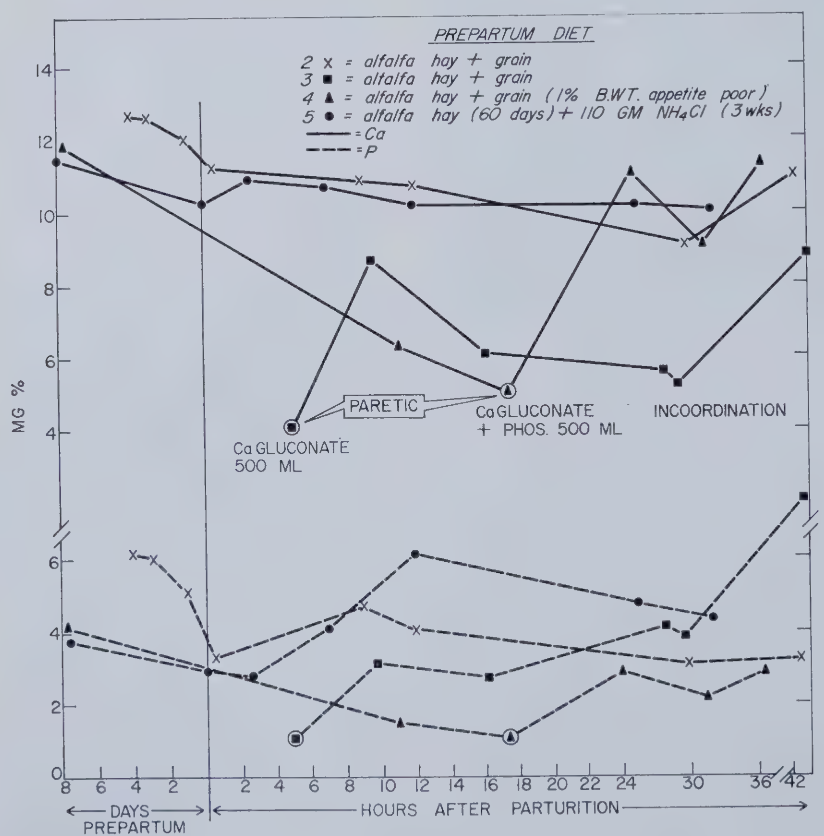
K. A. KENDALL, K. E. HARSHBARGER, R. L. HAYS, and S. L. SPAHR

THE IMPORTANCE of the prepartum diet in controlling parturient paresis (milk fever) continues to be brought out by research in the Department of Dairy Science. According to our latest work, feeding ammonium chloride to the dairy cow late in pregnancy may help to keep paresis from developing.

The paresis syndrome

Paresis affects some aged cows soon after parturition. It is characterized by abnormally low amounts of calcium and phosphorus and above-normal glucose in the blood and by a depressed appearance often accompanied by tetany. It was further described by Sampson et al. (1935) as being accompanied by a lower alkali reserve in the blood. Craige (1945), however, held an opposite point of view, attributing parturient paresis to an alkalotic condition due to an abnormal increase in the blood alkali reserve.

The latter viewpoint is supported by work in this laboratory. In one experiment sodium bicarbonate was included in the diet of nine cows late in gestation and ammonium chloride was fed to another nine cows. If fed in large enough amounts, sodium bicarbonate can have an alkalizing effect while ammonium chloride can have an acidifying effect. Five of the cows receiving sodium bicarbonate developed clinical paresis as compared with only one cow fed ammonium chloride. (For further information, see Kendall et al., Jour. Dairy Sci. 52:931. 1969.)



Blood serum mineral levels in cow 1883 before and after parturition. (Fig. 1)

Parturitions compared

The effects of ammonium chloride were further evidenced in an intensive study of cow 1883, a Jersey. This cow was fed different prepartum diets before her second, third, fourth, and fifth parturitions and comparisons were made of her blood composition shortly before and after each calving.

Before her second and third calvings, this cow was fed alfalfa hay and only a moderate amount of a concentrate mixture. This mixture consisted of ground shelled corn, ground oats, soybean meal, dicalcium phosphate, and trace mineralized salt, plus a low level of vitamin A-D mixture. Paresis developed after the third calving.

In preparation for the fourth calving, the cow was fed the same concentrate mixture as before, but at the rate of 1 percent of body weight daily. Alfalfa hay was also fed at about the same rate. During the latter part of the period she lost her appetite and did not consume adequate amounts of grain. About 17 hours after calving she again developed paresis.

Having had paresis after both her third and her fourth parturitions, cow 1883 was a prime suspect to develop it after her fifth calving. This made her a good subject for a test of the

K. A. Kendall and K. E. Harshbarger are Professors of Nutrition, Department of Dairy Science; R. L. Hays is Professor of Physiology (in Dairy Science); S. L. Spahr is Assistant Professor of Dairy Husbandry. Grateful acknowledgement is made to Drs. B. O. Brodie, R. D. Hatch, and J. C. Thurmon of the College of Veterinary Medicine, who diagnosed and treated paresis during the study; and to Dr. E. J. Eagelman, who performed the surgery for fistulating the cow.

effects of administering ammonium chloride.

To increase the odds in favor of paresis development, the cow was fed high-quality alfalfa hay, free choice, for the last 60 days before her fifth parturition. Other studies have considered that alfalfa is conducive to paresis because of its high calcium-to-phosphorus ratio or its alkalyzing effect.

During the final 3 weeks of gestation about 110 grams of ammonium chloride were introduced into the rumen through a fistula. The ammonium chloride was used to create a more acid condition in the rumen and possibly in the blood and urine.

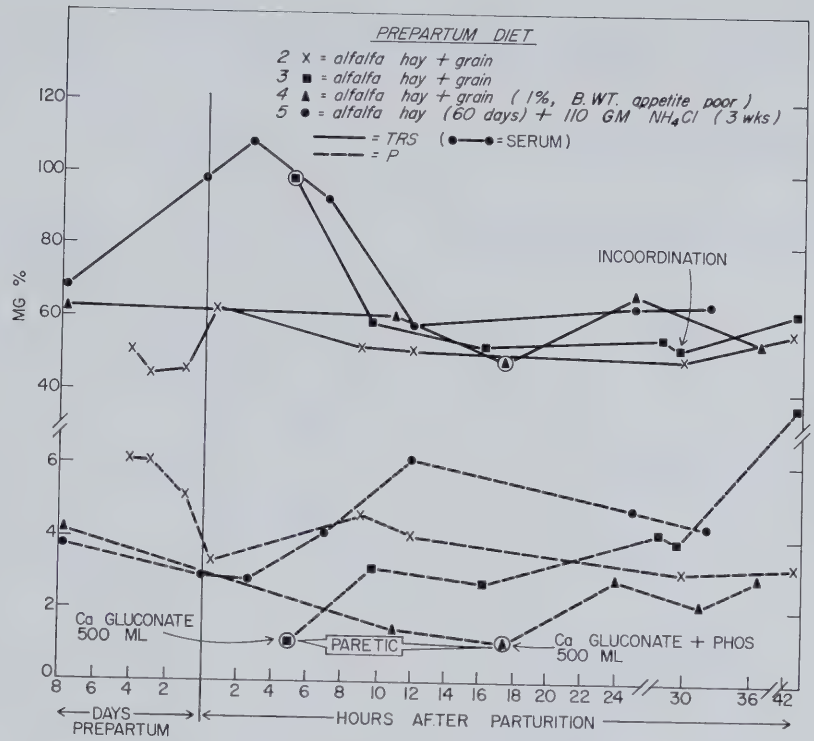
Rumen, blood, and urine samples were collected for study from the final days of gestation through the second day after parturition. Standard procedures were followed for measuring blood serum calcium (CA), inorganic phosphorus (IP), and total reducing sugars (TRS). Hydrogen ion concentrations (pH) in the rumen and urine were measured with an expanded scale pH meter. A special constant temperature blood electrode was used for measuring blood pH.

Paresis does not develop

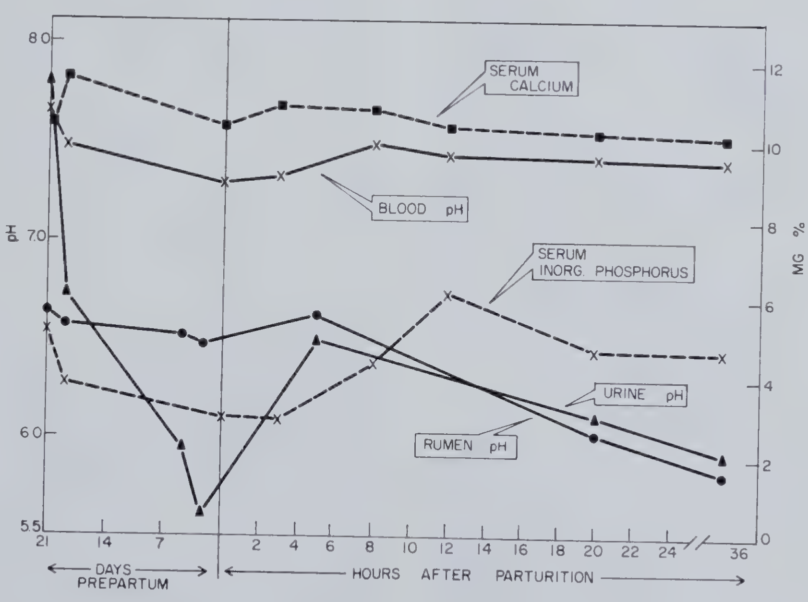
Despite her previous history of paresis, cow 1883 did not develop paresis after receiving a prepartum diet of alfalfa and ammonium chloride.

After the administration of ammonium chloride, blood calcium and inorganic phosphorus remained above the normal levels for parturient cows, and well above the levels observed during cow 1883's third and fourth parturition periods, when paresis was diagnosed (Fig. 1).

As observed in previous studies, the blood TRS levels inversely followed the IP levels (Fig. 2). That is, a low blood serum IP was usually accompanied by a high level of TRS.



Whole blood total reducing sugar (TRS) levels and blood serum phosphorus levels in cow 1883 before and after parturition. (Fig. 2)



Serum calcium and inorganic phosphorus in relation to blood, rumen, and urine pH when prepartum diet was alfalfa hay plus ammonium chloride. (Fig. 3)

As expected, the pH in the urine declined abruptly after the cow began receiving ammonium chloride (Fig. 3). The pH reached a high of 7.88 just before the cow began receiving ammonium chloride, then dropped to a low of 5.62 on the day before parturition. During the same period the blood pH dropped from 7.62 to 7.29, while the rumen pH declined from 6.62 to 6.12.

This study, we believe, supports the hypothesis that certain prepartum diets of the dairy cow are conducive to a relatively normal metabolic status, thus preventing or markedly reducing the possibility of paresis. In this instance, maintenance of a more nearly normal metabolism at parturition was probably influenced by the acidifying effect of ammonium chloride.

Family Life Education—Who Needs It?

MICHAEL J. SPORAKOWSKI

A HIGHLY VERBAL attack on school programs in family life and sex education has recently spread across the land.

Although such programs are innovations in many schools, they are not of overnight vintage. Anaheim, California, and Flint, Michigan, for example, have programs that date back years and have wide support.

The national spotlight really began to focus on family life education in the early 1960's. At that time, studies in Florida, Indiana, and Illinois indicated that courses in family life or sex education were reaching relatively few students. Only 25 percent of the Florida schools, 40 percent of the Indiana schools, and 68 percent of the Illinois schools offered such courses. The courses were generally elective, and in many schools only 10 to 25 percent of the students ever took any of them. Most of the courses were offered in Home Economics, attracting far more girls than boys.

College students surveyed

To update some of the research findings, the author recently conducted a survey of 70 students enrolled in an undergraduate course in family relationships. Average age of the students was 20.8 years. All but eleven were juniors or seniors, and all but four were women. The majority (80 percent) had a middle-class background.

The students were asked about the family life and sex education courses in the schools they had attended and about the sources of their information and attitudes in this area.

Eleven percent of the students had received some sort of family life education before the sixth grade; 63 percent, somewhere from the sixth to the twelfth grade.

Most of the courses were in Home Economics, with Physical Education, Health Education, and Biology being distant runners-up. The fact that most of the students in the survey were women probably accounts for the emphasis on Home Economics.

Asked what topics had been discussed in the elementary schools, the students mentioned "how to get along at home" and "how to use money" most frequently. At the secondary level, reproduction and venereal disease received the most mention.

Only 27 percent of the respondents had taken any college course, other than the one they were then enrolled in, which pertained to family life and sex education.

The respondents were asked to rate their families on their conveyance of information and attitudes concerning eleven areas often covered in family life education courses — for example, reproduction, parenthood, sex as a human relationship, childbearing, venereal disease. A five-point scale was used: 1, excellent; 2, adequate; 3, average; 4, inadequate; and 5, nonexistent.

In general, the students did not rate their families very high on the actual information that had been taught at home. The mean rating for all respondents bordered on "inadequate," although the range of responses included all five categories.

The composite rating for conveyance of attitudes was higher, bordering on "adequate." Apparently most families can pass on attitudes and values more easily than they can give factual information in this area.

Generally low ratings were given to both information and attitude conveyance about contraception, sexual deviancy, and sex as a human relationship — topics about which young people have many questions.

Critics of family life education usually maintain that home and church are the most appropriate places for such learning. As seen above, home did not rate very well as an information giver and not overly adequately as an attitude conveyor. The respondents' church training was not very helpful either.

Of the 61 who stated a religious preference, only 30 percent had received any family life or sex education through the church. Most of this group felt that the materials presented by the churches were too idealistic to be practical. Whether or not one agrees, the students apparently did not believe that their religious training was relevant to their future or present family life.

The church ranked behind friends and books as a source of family life-sex education. Friends were mentioned by 53 percent of the respondents and books by 37 percent. Physicians, movies, and youth groups were all mentioned by fewer than 5 percent.

Nearly all the respondents strongly believed that family life and sex education courses should be offered at all levels of school. Quite significantly, they also believed that parents should be involved in such an endeavor, and that churches should be more concerned with passing on values and information.

Broader programs indicated

These responses indicate a need for broadening and strengthening family life-sex education programs. It is not enough just to offer courses in this area. The courses should be offered meaningfully, utilizing research and many types of professional consultants, and should be available to all.

Meaningful family life education is not limited to reproduction but deals with sexuality in its broadest sense. It helps males and females to get along better with each other as friends, spouses, or parents. It provides guidelines for dealing with life in our complex culture, whether the task be budgeting, childbearing, or relating to others. In short, it is education for living, instead of education for occupation.

Michael J. Sporakowski is Assistant Professor of Family Relationships, Department of Home Economics.

4-H Adapts to Modern Conditions

R. O. LYON

THE 4-H PROGRAM of the Cooperative Extension Service is changing to keep pace with the times. Originally, its purpose was to improve young people's skills in farming and homemaking. Now the scope has been broadened to include skills and concepts that will enhance the "quality of living" for both urban and rural youth.

The new emphasis has come about as farms have been consolidated and increasing numbers of rural people have moved to the city. At first this trend brought uncertainties to the people who influence the direction of 4-H. There was a temptation to limit 4-H emphasis to the decreasing number of families living on farms, with a token bow to small towns where most families depended on agriculturally related occupations. A few states announced such a posture.

This position, however, was not a comfortable one as economists pointed out that only a few of the boys growing up on farms could find an active place in farming, and that only a few of the girls would be farmers' wives. Those who longed for the undisturbed rural program countered this criticism by emphasizing the value of a rural background to those youth who might enter farm-related occupations.

A nudge from urban influences more than 10 years ago resulted in an experimental 4-H program in the center of Chicago. New projects which were developed for this urban situation were soon adopted by existing 4-H clubs all over the state. Photography, small engines (lawnmower, outboard motor, snowmobile), electricity, automotive care, veterinary science, and geology found ready acceptance as projects leading to a hobby as well as broadening 4-H members' concepts of possible vocations.

R. O. Lyon is Associate Professor and State 4-H Club Leader.

TV programs

Improved communication methods have had their influence on the 4-H program. Michigan developed a 4-H TV Science series of 10 programs that were made available to other states. Each program was a simulated 4-H meeting, with talks and demonstrations by 4-H members emphasizing the scientific principles involved in many of the projects already in existence in the 4-H program, with some new ones like anthropology added for spice.

Soon afterwards, a second series, called TV Action, was made possible by Civil Defense funds. This series emphasized preparedness for disasters caused by weather as well as by nuclear fallout.

Illinois TV stations readily accepted this new program material, and seven stations broadcast the material in one year. Through the county Extension offices or the state 4-H office, prospective viewers could get materials suggesting simple experiments to be performed in conjunction with the TV shows. The youngsters also received the usual 4-H buttons, identification cards, and slogans.

In three years' time over 70,000 third, fourth, and fifth graders had the experience of feeling they belonged to a 4-H Club while watching TV and performing experiments at home or in school. Several teachers wrote to the state office, expressing appreciation for this science-enrichment material.

Bicycle safety

The next project showing the urban influence was in bicycle safety. Several school systems cooperated with Extension in large programs of bicycle safety instruction and testing, with appropriate recognition for work done. Is this 4-H? It is an example of time-tested Extension methods applied to a problem recognized by society. The 4-H name seemed to help in getting the attention of the children.

Numbers participating

In 1969 the Federal Extension Service required, for the first time, that the annual 4-H report should include the number of youth participating in short-term special interest programs such as TV and bicycle safety, as well as the number belonging to regular clubs.

According to this report, over 115,000 Illinois boys and girls had participated in 4-H programs during the previous year. Of this number 75,000 belonged to more than 3,800 local 4-H clubs. Another 5,000 participated in short-term special interest programs. An additional 31,000 participated in 4-H programs through TV Clubs in science and emergency preparedness. The number taking part in 4-H through TV can be expected to increase as new offerings in conservation, photography, and nutrition are prepared by a national TV committee.

As in the early days, homemaking projects still comprise about a third of the project enrolment, with new emphasis being placed on child care, home management, and consumer buying. Beef, swine, and dairy projects are just about holding their own in numbers. There has been a large increase in recreational horse and pony projects.

Place of residence of Illinois 4-H members has closely followed the national average, with about a third living in cities and suburbs, a third in country towns, and a third on farms.

While 4-H is still accommodating the traditional interest in agriculture and homemaking, the present emphasis on personal development and career exploration should be valuable for all young people, no matter where they live.

Early-Season Chemical Analyses of Corn and Soybean Plants Are Not Good Indicators of Analyses in Midseason

W. M. WALKER and T. R. PECK

SOME DAY, we hope, we will be able to predict corn and soybean yields accurately on the basis of plant analyses made early in the growing season. But a great deal of research will be required before this is possible.

For several years we have been correlating yields with chemical analyses of plant samples collected at midseason. Preliminary reports for corn were published in the Fall, 1967, issue of ILLINOIS RESEARCH; for soybeans, in the Fall, 1969, issue.

The analyses for this study were all made on leaves at a particular stage of development. Can the relationships that have been established between these analyses and yields be applied when plants are sampled at another stage of development? Specifically, can we use early-season plant analyses to predict later plant composition and, ultimately, yields?

To study these questions, we utilized data from surveys in 1967 and 1968 (ILLINOIS RESEARCH, Summer, 1968; and Spring, 1969). Plant and soil analyses were used to measure the nutrient levels of Illinois soils. The plant analyses were made both on whole-plant samples collected early in the season and on leaf samples collected at midseason. Whole-plant samples were collected when corn was 12 to 18 inches tall and soybeans, 5 to 10 inches. Midseason samples consisted of the sixth corn leaf (ear leaf) at early tassel and the topmost fully developed leaf on soybean plants when they reached full height.

So far we have collected 332 early and midseason soybean samples and 654 early and midseason corn samples. These samples represent a number of different crop varieties and a wide range of soil types, fertility treatments, and other environmental conditions.

The early-season analyses were compared with the midseason analyses by use of correlation coefficients (r). This statistic measures the linear association between two variables.

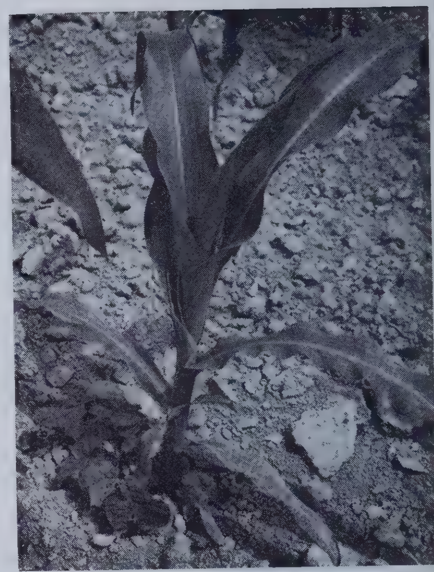
Correlations between chemical components of early and midseason samples of corn and soybeans are presented in the table below. Except for iron in both crops and nitrogen in soybeans, there was a significant association between levels of various elements in the early samples and the midseason samples. In general, this means that corn or soybeans which are relatively high (or low) in a particular element on a given site early in the season are likely to be high (or low) at the midseason sample period.

Although the correlation between early and midseason samples was significant, it was far from perfect. A perfect correlation would be indicated by an r value of 1.0. The only figure that comes anywhere near this value in the table is the correlation for manganese in corn. Knowledge of chemical composition at an early sampling period is thus of limited value in predicting the nutritional status of corn and soybeans late in the season.

Correlation (r) Between Chemical Components of Early and Midseason Plant Samples

Element	Correlation coefficients	
	Corn	Soybeans
Nitrogen	.293**	.043
Phosphorus	.279**	.366**
Potassium	.440**	.474**
Calcium	.332**	.307**
Magnesium	.576**	.546**
Boron	.265**	.385**
Copper	.190**	.310**
Iron	.032	.071
Manganese	.941**	.639**
Zinc	.339**	.446**
Sodium	.352**	.394**

** Odds are more than 99:1 against a chance correlation this large.



Early-season sampling stage for corn.

A number of possible reasons may account for the relatively poor precision of predictions based on early-season samples.

- Plant samples are from many different varieties, and it is possible that varieties differ widely in their uptake of elements at different stages of growth.
- Sidedressing fertilizer after plant emergence may affect the nutrient content of plants at midseason but not early in the season.
- Weather conditions such as temperature and rainfall may influence the differential uptake of one or more elements at different periods.
- It is possible that element concentrations may change as plants become more mature.
- The rate at which elements are diluted in the plant may vary with stage of growth.

According to these results, yield-plant analysis relationships established in midseason will be difficult to apply to plant analyses obtained at the early period. It may be necessary to sample research plots at two or more stages of growth and correlate each set of data with subsequent yields. Until this is done, it will be hard to predict corn and soybean yields on the basis of chemical analysis of early plant samples.

W. M. Walker is Associate Professor of Biometry and Soil Fertility; T. R. Peck is Associate Professor of Soil Chemistry.

Strategies for Worldwide Agricultural Development

W. D. BUDDEMEIER

Agricultural development is a never-ending process. We think of the United States as a developed nation, but this is true only in a relative sense. A striking realization is that the most and the least developed countries face basically similar problems. This similarity has become apparent as U.S. universities have aided sister universities in the less-developed countries in their efforts to make major contributions to agriculture and the general economy.

Problem similarities

One universal problem is that of food production. In one country the problem may be one of scarcity, low incomes, and starvation; in another, plenty and unprofitable prices. In either situation the basic questions are: What to produce? How much to produce? What prices to charge?

Closely related to food production, or to agricultural production in a broader sense, is the problem of sharing the economic benefits of development. In the United States many people are concerned because a relatively few large operators are receiving a large portion of the payments for complying with governmental programs, as well as the benefits from new technology. Observation suggests that a similar distribution-of-gains problem exists with respect to benefits from new technologies leading to the "green revolution" in India. The people with the most land and capital probably receive a major share of the benefits.

What priorities should be given to major problems? How much emphasis should be placed on agriculture, industry, defense, welfare (including health and nutrition), population control, and governmental involvement? These problems are relevant to all countries. Differences are in the resources available to solve them, the relative importance of different sectors of the economy, the magnitude or intensity of the problems, the nature of the governmental processes, and the existing social and institutional structures.

Experiences provide lessons

The experiences of countries in varying stages of development should provide many lessons for the developing countries. It is sometimes difficult, however, to evaluate the policies and programs that have helped or hindered the development of agriculture and the total economy. Technological progress in the United States, for example, has been accompanied by environmental and nutritional problems that most of us failed to anticipate.

Despite the difficulties of evaluation, it should be possible to use past and present experiences in developing a substantive body of knowledge, theory, and principles about economic development and the relationship between it and agricultural development. A considerable amount of research has been done on segments of the problem, but much remains to be done. Not only do the individual pieces of the problem need more intensive study, but the results of research in several subject matter areas must be synthesized into a meaningful total approach.

Technological progress and economic progress are essential, but alone they are inadequate. At some point in the history of developing countries, technological advances may run counter to the existing social structure and the political, religious, and educational institutions. The resulting problems might be approached by multi-disciplinary team research, involving economists, sociologists, and other specialists as co-workers with physical and biological scientists.

Research project implemented

A research project designed to study strategies for agricultural development, along with its relationship to total development, was implemented this past fall. Limited funding is available for about 18 months. It is hoped that enough progress can be made to justify continued funding.

Teams of faculty members will work on various subprojects. They will have the opportunity to travel to foreign countries so that they can make preliminary studies and establish research programs. There are also limited provisions for sending graduate students abroad to do research.

First efforts will be concentrated in Sierra Leone and in two states of India (Uttar Pradesh and Madhya Pradesh), where we have ongoing programs. Supply, demand, and marketing of agricultural products will be emphasized.

Several proposals for subprojects in India are under consideration. They are designed to make more meaningful projections of agricultural production and to find cropping systems that will use land more efficiently.

An interesting situation in West Africa particularly merits study. Several developing countries are emphasizing rice production, with each country hoping to export rice to neighboring countries. Obviously they cannot all export rice to their neighbors. What would be an appropriate strategy on a regional basis?

Only a few segments of the total problems can be studied now. But the scope for expansion, depending on the availability of funds and personnel, is unlimited. Ultimately the work will be most meaningful if it can be expanded to include research in countries in different stages of development and if we can establish continuing cooperative relationships with some outstanding foreign institutions.

W. D. Buddemeier is Acting Director of International Agricultural Programs.

FARM BUSINESS TRENDS

THE DECADE of the 1970's will bring many changes to agriculture. For the most part these changes will be continuations of trends that were prominent during the 1960's.

The number of farm workers (owner-operators, tenants, and hired laborers) will decrease much further. The bigger tractors and larger-capacity field machinery now coming into use greatly reduce the labor requirements for crop production. The mechanization of the animal enterprises likewise reduces the labor needed for the production of meat, milk, poultry, and eggs.

The decrease in farm employment during the 1970's, while expected to be large, probably will not match the decline that occurred during the 1960's. Between 1960 and 1969 farm employment decreased from 7,342,000 to 4,317,000 for a decline of 41 percent.

Family farms will continue to hold a dominant place in agriculture. Farm employment figures for the 1960's show that the family-operated farm has held its strong position. The proportion of family workers in the farm labor force increased from 73 percent in 1959 to 76 percent in 1969.

The animal industries will continue the change from sidelines on general farms to specialized large-scale operations. The bird industries — producing broilers, eggs, and turkeys — have led the way. Of the three major cattle industries, cattle feeding is most specialized, dairying is intermediate, and beef cattle production is still carried on in relatively small units because of the large areas needed for pasture. Large-scale swine production, heretofore held back by complex management problems, will become common during the 1970's. Crop production will continue to be carried on mostly as one- or two-man operations, in part because expansion by one farmer almost always involves the direct displacement of another.

Inflation will continue to squeeze the entire farming industry. Wage earner groups are becoming more militant in their demands for bigger slices of the national income pie. Productivity cannot keep pace with the demands of these groups, so prices of most goods and services will rise strongly. The rise will be detrimental to farmers in three ways: (1) It will raise prices of farm supplies and equipment. (2) It will increase processing and marketing costs, which will take a large share of the consumer's increased food expenditures. (3) It will raise the cost of commodities and services required for family living.

One result of inflation will be that interest rates will continue at very high levels. The reason for this is that many lenders will insist upon getting enough interest to offset the shrinkage in the buying power of the money that they lend.

High interest rates will make it difficult for young men with little net worth to be successful in farming. The families that have substantial financial resources will have a big advantage.

Farm price and income support programs have been used in this country for 40 years, and seem likely to be continued through the 1970's. As in the past, there will be evolutionary changes. These probably will include limitations on the size of payments to individuals, less emphasis on price support for *commodities,* and more effort to help rural *people* secure and hold a more favorable position in the nation's economy. The continued movement of industry into rural areas will provide good employment opportunities to many rural communities, but not to all. Many people will have to move in order to obtain a satisfactory place in our prosperous society. — *L. H. Simerl*

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Spring, 1970

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Barley root-knot nematode inoculum that has been extracted from infected roots is added to pots of sorghum to determine effects of this new disease (page 3).

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SOME STRENGTHS AND LIMITATIONS OF THE COLLEGE OF AGRICULTURE

Unquestionably, the greatest strength of the College of Agriculture is that it is people-oriented. Its purpose is to help people improve themselves through education.

Another basic strength of the College of Agriculture at the University of Illinois resides in its legal obligation to supervise the Cooperative Extension program in agriculture and home economics for the entire state and to conduct research for the benefit of the state and the nation through the Agricultural Experiment Station. The teaching function of the College is tremendously strengthened through the relationships of the instructors with these research and extension activities. Almost all of the teaching faculty have part-time responsibilities in research and this results in a staff alert to the problems facing the producers, processors, and marketers of agricultural products.

In recent years the College has become increasingly involved in the agricultural problems of the developing countries, not only through AID contracts but through the efforts of individual professors working on a variety of other projects. This international effort has broadened the vision of staff members and increased their comprehension of world agriculture.

Another strength of the College is the availability of University resources — the library, for example, and the collective competence of the staff in physical, biological, and social disciplines. Still another strength is the faculty's continuing concern for student welfare, as evidenced by a well-coordinated advisory program and by a personalized placement program.

The limitations on the College are most apparent in the inadequate laboratory and office facilities of some departments. Operating budgets are an even greater limitation. The graduate training program expands too slowly because of necessary limitations in the numbers of assistantships available. Occasionally research activities are directed by the availability of federal and foundation grants rather than by the major needs of agriculture. Further, the present policy of providing operating funds largely on the basis of student enrolment tends to deny that the college has responsibilities unrelated to student numbers. — *Karl E. Gardner, Associate Dean and Director of Resident Instruction*

The Barley Root-Knot Nematode

Although not yet a problem in Illinois, this pest can attack a number of important crops

. B. MALEK, D. P. TAYLOR, and D. I. EDWARDS

A PEST that can attack barley, wheat, oats, sorghum, soybeans, nd bentgrass has made its way into llinois. This is the barley root-knot ematode, *Meloidogyne naasi*. So ar its only appearance in Illinois as been on creeping bentgrass on few golf courses near Chicago.

Elsewhere in the United States, occurs in barley fields in Oregon nd northern California, some Kansas rghum fields, and a Kentucky golf ourse. It has also been reported in ngland and Belgium.

M. naasi may cause severe losses all infected crops except bentgrass. he situation in northern California so critical that growers are reired to rotate barley with a nonhost op on any infested land leased om the federal government.

M. naasi has not yet been reported attacking soybeans in the field. owever, soybean did prove to be a st in our greenhouse studies.

mptoms — what to look for

Field symptoms are identical in all fected crops. Usually affected areas e circular to oval in shape, varying om a few feet across to several acres size. Plants within these areas pear dwarfed and yellowish. The nting and discoloration are most nspicuous in the center of infested as, tending to diminish toward the ges. *M. naasi* cannot be diagnosed the basis of these symptoms alone, wever, for similar symptoms can produced by a number of causes.

3. Malek is Assistant Professor of Nemagy, Department of Plant Pathology; D. P. lor, Professor of Nematology; D. I. Edds, Assistant Professor of Nematology and natologist, USDA, ARS, Crops Research sion.

These include other disease-causing organisms, poor drainage, and low soil fertility.

The characteristic symptoms produced on infected roots are what distinguish *M. naasi* damage from damage due to other causes. By carefully digging — not pulling — affected plants from the soil, one can see abnormal swellings or galls on many or all roots (Fig. 1).

Four types of swellings have been caused by *M. naasi* in our research: (1) club or hook-shaped galls on root tips, (2) pear-shaped swellings on short, side roots, (3) spindle-shaped galls formed behind root tips, and (4) root rings or spirals with rootlets on their outer curvatures.

Individual swellings are about ¼ inch in diameter and ½ inch long. They are a little larger on sorghums than on other host plants. When roots are heavily infected, the galls tend to fuse together so that a large part or all of the root may be swollen (Fig. 2).

If you find plants with these symptoms, notify your county Extension adviser at once. For final diagnosis, he will need to send samples to the University's nematology laboratory without delay.

Life cycle

M. naasi begins life as a single-celled egg, less than 1/250 inch long, usually deposited in an infected root (Fig. 3). Cell division begins immediately, continuing until a worm-shaped larva hatches. This larva is in the second stage, having passed through one molt within the egg. In our studies at 75° F. it takes about 2 weeks for the larva to develop and

These barley roots display typical swellings caused by *M. naasi*. (Fig. 1)

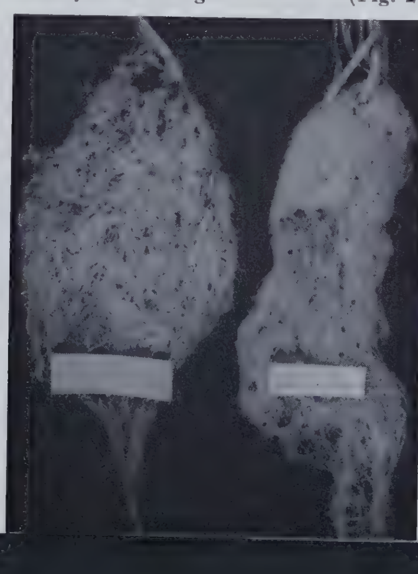
hatch. The larva then migrates either into the soil or to a different place in the root.

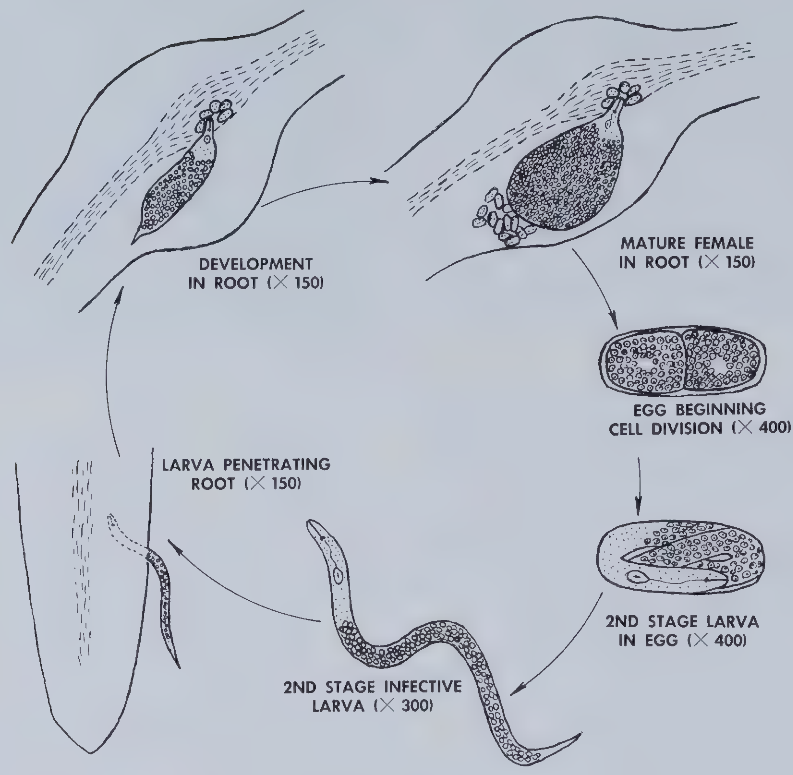
In the soil the larva locates a suitable root which it penetrates by repeatedly thrusting its feeding structure, the stylet, against cells on the root surface. After a hole is formed, the larva forces its way into the root. Then it moves through the root by making holes in cells or pushing them apart.

Within 2 to 3 days the larva becomes settled with its head close to the root's developing conductive tissues and its body outstretched and parallel to it. After feeding begins, the nematode begins to grow in diameter, matures, and loses its ability to move.

The maturing process takes about 21 days. During this time the nematode goes through additional larval stages interspersed by molts. The only growth is in diameter, so that the young adult female is about as long as the second stage larva that infected the root — or about 1/60 inch. It has a spherical body, 1/40 inch in diameter, and a narrow neck. The cycle is

Infected barley roots are shown at left; healthy roots at right. (Fig. 2)





Life cycle of the barley root-knot nematode. (Fig. 3)

completed when the female starts laying eggs. The male develops in the same way as the female, except that it reverts to a worm shape after the last molt.

Roots begin to swell within a few hours after infection. After 4 or 5 days important microscopic structures can be seen in the conductive tissue. These are the enlarged, multinucleate, giant cells upon which *M. naasi* feeds throughout its life. Rapid enlargement of these cells, abnormal cell multiplication and enlargement, and the growth of the nematode contribute to the swellings on the roots.

Control with crop rotation

The barley root-knot nematode must feed on roots of susceptible plants to survive and reproduce. Unlike cyst-forming nematodes such as the soybean cyst nematode, *M. naasi* has no resistant stage that allows it to survive without food. If no host plants are grown on an infested field for a year, this nematode can be almost eliminated by starvation. This is the basis for the required one-year rotation in infested barley fields in California.

Fortunately, the barley root-knot nematode appears to have only a small number of host plants that must be avoided in a rotation. These include sugarbeets plus the crops already mentioned. Perhaps other crops may serve as hosts but they have not yet been reported. California recommends growing alfalfa, potatoes, onions, or peas as nonhost crops.

Corn infections have never been observed in the field, nor has corn become infected in our greenhouse tests. Corn would thus be our first choice as a nonhost in a rotation program to control *M. naasi.* Alfalfa and other legumes, except soybeans, also appear safe to use although they have not yet been fully tested in Illinois.

Chemical control

The barley root-knot nematode is easily controlled by most nematicides. Because of their high initial cost and the probable need for annual application, however, these chemicals are not economically feasible in Illinois except on high value crops such as bentgrass. A nonphytotoxic nematicide must of course be used on established bentgrass plantings.

Resistant varieties

Crop varieties resistant or immu to this nematode will provide an e cellent method of control in the f ture. No breeding programs ha been started specifically to produ varieties resistant to *M. naasi;* ho ever, some existing varieties are ready highly resistant.

Of 47 oat varieties we have teste no galls were produced on 11 sele tions from various parts of the worl Of the varieties grown in Illinois, Wi tok and Garland were only ligh galled; Newton was the most heav galled.

Wheat and barley, in general, a more susceptible to *M. naasi* than a oats. All barleys tested (Dickso Harrison, Traill, and Trophy) a very susceptible, as are Benhur, C Gage, Monon, Pawnee, Riley, Selki and Vermillion wheats. Differences varietal reactions suggest that high resistant varieties could be develop rather easily if necessary.

Research in progress

Since *M. naasi* threatens so ma crops vital to Illinois agricultu several research projects on this ne atode are under way in our labo tories and greenhouse. Most essent is a comparative study of *M. na* from Illinois, California, Kansas, E gland, and Kentucky. The purp is to determine whether the isola behave alike, regardless of geograp origin, or whether they vary in th effects on the different host crops

This information is necessary in ciding whether research done el where will be of value to Illin growers. In the meanwhile we can safely accept California recommen tions for crop rotations that have been tested locally.

In related research we hope compile a more complete list of h plants and a list of crops that can safely used in a rotation to cont *M. naasi.* Since this is the first rep of *M. naasi* attacking the soybe much work is in progress to determ the amount of potential damage this crop. The effect of *M. naasi* diseases caused by other organism also being studied.

Nonfarm Income of Commercial Farmers

R. J. HANSON

T IS DIFFICULT to imagine a full- time farm operator studying the ˈelp Wanted advertisements in the ıcal newspaper. Yet in a study of ɔ9 full-time commercial farmers in ɛntral Illinois for 1968, 30 percent id that they had off-farm employ- ent. Altogether, 55 percent reported age or salary income, whether ırned by themselves or their wives.

All but one farm operator reported me source of nonfarm income. Non- rm income included wages and laries (61 percent of total nonfarm come), dividends (6 percent), in- rest (9 percent), rent (0.3 percent), nsions (0.3 percent), royalties (0.2 rcent), trusts (3.2 percent), non- rm business income (11 percent), d miscellaneous income (9 per- nt). Although wages and salaries ɛre the largest source of nonfarm come, interest and dividends were ported the most frequently.

The farm wife was the major wage d salary earner. Of the operators porting wage and salary incomes, percent said that the incomes re earned entirely by their wives. ie out of every four wives worked tside the home. These wives ac- unted for 72 percent of total wage l salary income and 44 percent of al nonfarm income.

The wives' earnings averaged 216. Most working wives held -time jobs requiring special skills advanced education such as teach- , nursing, and secretarial work.

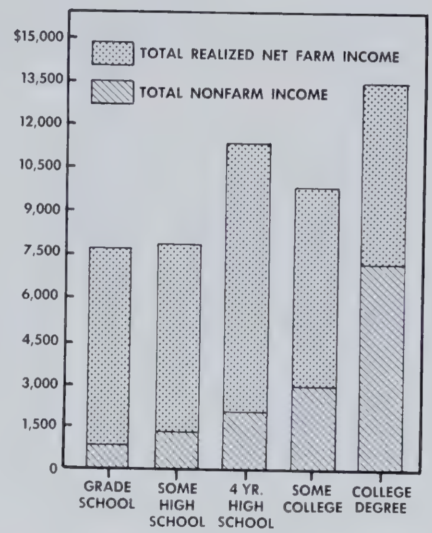
n 28 percent of the families, the n operator was the only wage or ry earner. These operators earned percent of the total wage and ry income and 17 percent of the l nonfarm income. Their wage salary income averaged $1,405, e most of them held only part- jobs off the farm.

arm operators who reported $2,000 or more from wages and salaries, whether earned by themselves or their wives, accounted for 90 percent of the total wage and salary income and made up 39 percent of all farm operators. This group had an average wage and salary income of $5,942. They tended to have smaller farms and fewer livestock than the other operators. Also, the percentage of farms with no livestock at all was highest among this group.

Total nonfarm income and income from wages and salaries decreased as farm and family earnings increased. Farm and family earnings include the value of farm production less cash operating expenses and depreciation. Nonfarm income amounted to 110 percent of the total realized income for farm operators with negative farm and family earnings.

As farm and family income increased, wages and salaries became a smaller percentage of total nonfarm income, while the proportion of interest and dividends increased.

Wage and salary income increased with both the age and the educational level of the operator. Also with increasing age and education, wages and salaries became a larger percentage of total nonfarm income, and nonfarm income became a larger percentage of total realized income.



Total realized income according to educational level of farm operator.

Farm operators with college educations reported slightly more earnings from nonfarm sources than from farming. These operators had an average nonfarm income of $7,071, since they received the highest wage and salary income along with the largest amounts of nonfarm business income, interest, and dividends.

Farm and Nonfarm Income Averages According to Level of Farm and Family Earnings

Type of income	Level of farm and family earnings					
	$0 or less	$1 to $4,999	$5,000 to $9,999	$10,000 to $14,999	$15,000 to $19,999	$20,000 or more
Total realized income	$3,837	$6,749	$9,972	$14,539	$15,539	$20,881
Total realized net farm income	−389	4,286	7,566	12,211	14,969	20,066
Total nonfarm income	4,226	2,464	2,406	2,328	570	815
Wage and salary	3,689	2,021	1,454	938	169	372
Nonfarm business	0	−48	436	292	0	−29
Dividends	138	50	64	318	161	117
Interest	66	177	146	376	121	306
Rental	0	2	9	22	29	−79
Miscellaneous	294	193	172	291	87	122
Royalties	0	2	6	2	0	3
Trusts	39	45	116	83	0	0
Pensions	0	19	2	8	0	0
Number of farm operators	17	48	126	75	15	18

Hanson is Research Assistant in Farm ıgement. This report is based on a Mas- thesis done under the direction of J. E. , Professor of Farm Management.

Nibble Your Way to Better Health?

One solution to the problem of obesity may be to snack frequently instead of eating a large evening meal

GILBERT A. LEVEILLE

THE OLD admonition against between-meal snacks and the recommendation of three "square meals" a day may go the way of the horse and buggy if man responds to the ingestion of infrequent meals as does the laboratory rat. Research in the Department of Animal Science suggests that "nibbling" throughout the day is less likely to cause obesity than is the ingestion of a single, daily meal.

A serious problem

Obesity is generally recognized as a significant public health problem in the United States. Over 20 percent of the population is estimated to be overweight, and this percentage seems to be increasing. The seriousness of obesity becomes apparent when one considers that the mortality rate for obese individuals is considerably higher than for individuals of normal weight.

The reasons for the increased incidence of obesity are not completely clear. To be sure, the relative reduction in calorie expenditure which has accompanied automation has caused some people to gain weight. Others, however, have adapted to this situation without depositing excess fatty (adipose) tissue. Evidently people vary widely in their propensity for fat deposition. Many individuals are now recognized to be genetically predisposed toward obesity, but the metabolic reasons for this predisposition are not yet understood.

Adipose metabolism studied

Extensive research on the factors regulating the metabolism of adipose tissue is under way in the Department of Animal Science. For many years this tissue was considered to be a mere repository for fat. It is now recognized, however, that adipose tissue is metabolically active and is responsible for most of the fat synthesized in the body of many species, such as the rat, mouse, and pig. This tissue is therefore the obvious place to look for aberrations of metabolism which could lead to obesity.

We have found that the metabolic activity of adipose tissue in the rat can be markedly altered by the time sequence of feeding. The changes in rats fed one 2-hour meal a day (meal eaters) as contrasted to rats fed ad libitum (nibblers) may be significant in understanding some of the factors contributing to human obesity.

In one of our early experiments it became obvious that meal-fed rats were far more efficient than nibbling animals in converting their food energy to body weight gain. Although the meal-fed rats consumed only about 75 percent as much food as the nibbling rats, they gained weight at the same rate. Such an effect could be due to several factors, but basically would have to result from either a decreased energy output or a greater metabolic "efficiency."

Energy expenditure can be divided into that required to maintain essential body processes or the basal metabolism, and that utilized for physical activity. We found that the basal metabolic rate was identical in meal-fed and nibbling rats. An experiment was then conducted to determine whether the physical activity was influenced by feeding pattern. The rats were housed in revolving cages connected to a counter which recorded each turn of the cage. The activity was measured during the daytime (8 a.m. to 4:30 p.m.), which is norma the least active period for rats, a during the night.

Daytime activity was about same in both groups, but at night nibblers were more than twice active as the meal eaters. Total tivity during a 24-hour period about 50 percent less for the meal- rats than for the nibblers. Thus, apparently greater efficiency of me fed rats is at least partly due to reduction in physical activity.

According to numerous studies, meal-fed rat converts about 50 p cent of the energy ingested daily fat. Over 95 percent of this synth occurs in the adipose tissue. therefore undertook extensive stu of the adipose tissue of meal-fed r

The capacity of adipose tissue convert carbohydrate to fat was m sured by incubating the tissue in buffer solution that was similar body fluids in composition and maintained at body temperature. buffer contained glucose "tagg with radioactive carbon. The abi of the tissue to convert carbohyd to fat could be evaluated by de mining the amount of radioactive bon in fatty acids. As a result these experiments we learned that tissue of the meal-fed animals ha much greater capacity to synthe fatty acids than did the adipose sue of nibbling rats.

In our next series of experim we evaluated the metabolic "mach ery" responsible for fat synthesis the adipose tissue. Cellular react are carried out by protein catalyst enzymes. The enzyme proteins, p ent in extremely small concentrati permit reactions to proceed m faster than would otherwise be

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ible. In fact, without enzymes most eactions would not proceed at all. Numerous enzymes are present in very body cell, each catalyzing a ery specific reaction.

Many enzymes are needed to conert carbohydrate to fat. For our :udy, we selected 16 enzymes which re apparently needed for "pacenaker" reactions. Of these enzymes, 2 were found to be significantly nore active in adipose tissue of mealed rats than in tissue of nibbling aninals. Thus the adipose tissue of neal-fed animals has the intracellur machinery to convert much larger uantities of carbohydrate to fat. ould such changes be partly reponsible for the development of obety in certain individuals? The nswer to this question is now being ught.

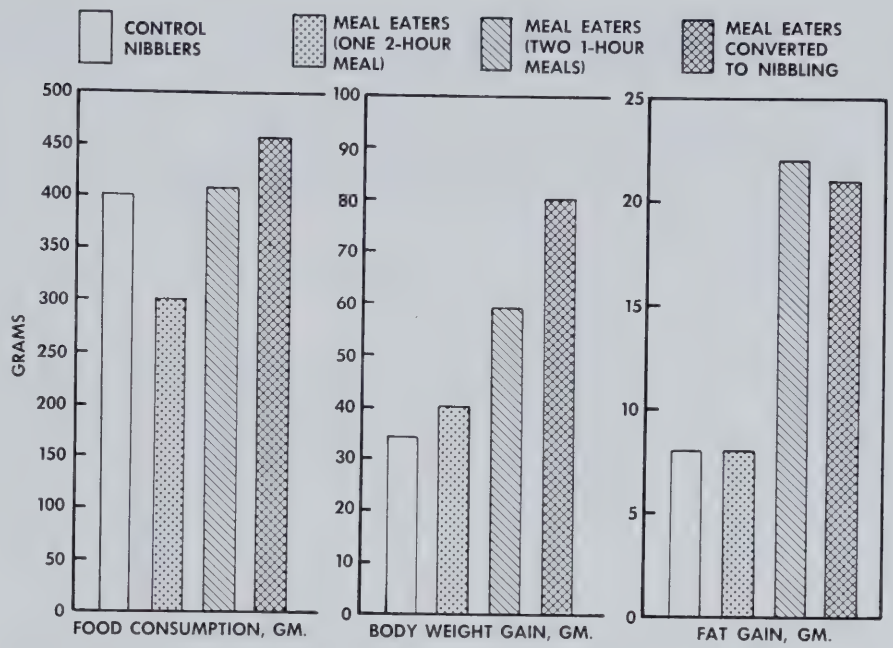
ating patterns changed

In another portion of the research, e studied the effects of changing the ts' feeding habits. For this study, e made a group of rats meal-eaters feeding them a single, 2-hour meal ily. They were then divided into ree groups. One group continued receive the single 2-hour meal. A cond group was fed two 1-hour eals (8 to 9 a.m. and 4 to 5 p.m.), hile a third group had unrestricted cess to food. These feeding scheds were imposed for 3 weeks. A urth group of rats, which served as ntrols, had unlimited access to food roughout the experiment — that is, ey were never meal eaters.

During the 21 days of the experint, the rats fed one meal a day ate s than the control nibblers, the rats l two meals a day ate about the me amount as the controls, while e rats returned to ad libitum feed- ate more than the controls (see art).

Although the rats fed one meal a y ate less than the controls, they ned essentially the same amount weight and the same amount of . Rats eating two meals a day, alugh consuming the same amount food as the controls, gained more ght and more fat.

The meal eaters that had been



Effect of food intake pattern on amount of food consumed, body weight gain, and body fat gain during the 21-day period.

changed to nibblers gained far more than the controls. This result was to be expected from the food consumption of these animals. After 3 weeks, adipose tissue of rats that had been trained as meal eaters and then allowed to nibble, still showed the metabolic activity characteristic of meal eaters.

Applicability to man

One might well question the value of such data, for man is surely different from the rat! However, enough metabolic similarities have been shown for the rat and man that hypotheses about man can be derived from data obtained with rats. These hypotheses of course need to be tested with human volunteers before any definite conclusions can be drawn concerning the significance of eating patterns in man.

Certain speculations are possible even before the hypotheses are tested. Many obese individuals are known to eat less food than lean people, but to ingest most of it as a large evening meal. It seems conceivable that these obese humans might be similar to the rats fed two 1-hour meals a day, which ingested the same amount of food as the control animals but gained more weight and body fat.

Another factor of potential importance is the eating pattern during weight-reduction programs. Most of the calories in weight-reducing diets are consumed at the evening meal. Is it not possible that such an eating pattern would affect the fat-synthesizing tissues in a manner similar to that seen in the adipose tissue of meal-fed rats? Then, when caloric intake is increased after a period of weight loss, the ensuing situation would be similar to that seen in the rat which is first meal-fed and then fed ad libitum. That is, weight gain and fat deposition would increase markedly. After all, obese individuals often lose weight while on a weight-reducing diet only to later regain the lost pounds and sometimes more.

These are some of the more obvious parallels which can be drawn from this work. The research with rats will yield a better understanding of lipid metabolism, particularly as it is affected by pattern of food intake, and will provide information which we hope will help us understand the problem of obesity. The importance of gaining this understanding is obvious, for we cannot hope to control that which we do not understand.

Growing Hardwoods in a Pine Plantation

After 25 years of pine growth, a once-poor site has improved enough that yellow poplar now competes well

R. A. YOUNG, A. R. GILMORE, and W. R. BOGGESS

WHEN THE WHITE MAN came into southern Illinois, he found vast areas of hardwood timber. About 3½ million acres or nearly 90 percent of what are now the 16 southernmost counties, were originally covered by forests. Some of the hardwood trees were as fine as grew anywhere in North America.

It was inevitable that the early settlers should clear the best of this area for agriculture. But they also cleared thousands of acres that were unsuited for farming. In addition, improper cutting, fire, and grazing reduced the productivity of the remaining woodland. As the result of these poor land use practices, coupled with high rates of erosion, large acreages were abandoned from agriculture, particularly during the depression years of the 1930's.

If planted before the pines are thinned, yellow poplar seedlings survive well but growth is slow. (Fig. 1)

Reforestation of these abandoned lands was begun in the 1930's with the advent of the CCC. However, the site quality of the area had deteriorated so much that native hardwood species could no longer be grown successfully. It was necessary to go down the ecological scale and find species with less exacting site requirements for the reforestation program. Two southern pine species, shortleaf (*Pinus echinata* Mill.) and loblolly (*P. taeda* L.), have proven to be well adapted to the area, although the former is growing at its extreme botanical range, while the latter occurs naturally about 150 miles to the south.

By now, about 20,000 acres of shortleaf pine plantations in southern Illinois are more than 25 years old. On average sites, the growth rate begins to decline after about 25 years. Foresters recommend that plantations which have reached this stage should be considered for harvesting.

After the pine is cut, the question arises as to how the land should be managed to insure a desirable new tree crop in a minimum length of time. One obstacle in managing these stands is that cherry (*Prunus* spp.) and sassafras (*Sassafras albidum* [Nutt.] Nees), are likely to take over an area after the pine has been removed.

One method of management is being demonstrated in a current study by the Department of Forestry, University of Illinois, in cooperation with the Shawnee National Forest, U.S. Forest Service.

R. A. Young is Associate Forester; A. R. Gilmore, Associate Professor of Forestry; W. R. Boggess, Professor of Forestry and Head of the Department of Forestry.

Where all pines are cut, yellow-popr growth and survival are good. (Fig.)

Yellow poplar planted

Yellow poplar (*Liriodendron tul-fera* L.) seedlings were planted ir a 32-year-old shortleaf pine plantati that had been thinned to varis levels.

Yellow poplar was an import:t tree in the original hardwood for:t that covered southern Illinois. Its the tallest of our broadleaf spec3, having an average height of 80 to 10 feet, and reaches a diameter of 4o 6 feet. For good growth and for, however, it has exacting soil ad moisture requirements.

The plantation in this study is growing on a Robbs silt loam sl, which developed under forest veget-

ion in about 50 inches of loess, over ,andstone bedrock. Erosion has re-luced the top soil to about 7 inches. [he subsoil is slowly permeable be-:ause of an impervious layer.

The various thinning levels in the ›lantation were: (1) complete re-noval of pines, (2) heavy thinning, 3) medium thinning, (4) light thin-ıing, and (5) no thinning. The plots, vhich were 1/20 acre in size, were hinned in March, 1966, and the ısable material was removed from he area. All the woody underbrush vas cut to the groundline in all the hinned plots, but not in the un-hinned plots. Yellow poplar seedlings vere then hand-planted on all plots t a spacing of 6 x 6 feet.

;rowth and survival

After four growing seasons, growth ıeasurements and survival counts ere made on the nine yellow poplar eedlings in the center of each plot. 'his minimized any effect due to eatment in adjacent plots.

Yellow poplar survival was the ıme, regardless of the thinning level ı the pine overstory. However, the ıinning level did affect the height the seedlings. Those on the plots here all the pine had been removed ere significantly taller than those on ıy of the other plots (Table 1). lso, there was a significant differ-ıce between trees on the heavily inned plots and those on the un-inned plots.

atural hardwoods

Natural hardwood reproduction as significantly greater on the plots ith pine completely removed than ı the other plots (Table 1). The ırdwood reproduction represented pid growth of sprouts from larger ırdwoods cut in the thinning opera-ın and of uncut seedlings or small plings. The volunteer hardwoods eraged 8.3 feet in height on all the inned plots.

Composition of the natural hard-ood growth varied greatly with de-e of thinning (Table 2). Ash, for ample, represented 26.9 percent of e hardwood growth on the uncut ots, but only 12.1 percent on the plots from which the pine had been completely removed. The percentages of persimmon and red oaks also de-creased greatly. As expected, the per-centages of cherry and sassafras increased on the plots where all the pines had been harvested.

Table 1. — Height of Yellow Poplar and Amount of Natural Hardwood Reproduction With Varying Intensity of Pine Thinning

Pine thinning intensity	Yellow poplar, average height	Hardwood reproduction[a]
	feet	*trees per acre*
Complete removal	12.1	2,760
Heavy	7.7	1,700
Medium............	5.7	1,260
Light	6.0	1,100
Unthinned..........	2.8	680

[a] Plants 5.0 feet and taller.

Total percentage in the understory of species with commercial value (the first nine listed in Table 2) remained fairly constant at about 62 percent, regardless of the level of thinning.

Yellow poplar competes well

The performance of yellow poplar in this study demonstrates that this species can be established under a shortleaf pine plantation, although growth is slow on the plots with medium, light, or no thinning. The good growth of yellow poplar where pine was completely removed suggests that it can be planted after pines have been clear-cut and can successfully compete with the previously estab-lished hardwoods.

It is possible that yellow poplar could be planted before the pines are completely harvested. Three years after the seedlings were planted, the pines were cut on one-half of the pre-viously unthinned plots. The yellow poplar on these plots was only 1.9 feet tall after three growing seasons. One year later, yellow poplar was 3.6 feet tall where the pine had been re-moved and only 2.8 feet on the re-maining unthinned plots. Cutting the pines did little damage to the yellow poplar seedlings.

As the result of other studies, light thinning of pine plantations before final harvest is recommended on good to medium sites. The practicality of thinning depends on the control of *Fomes annosus,* a fungus that causes a serious root rot of pines and that is often spread by thinning. If this con-trol can be achieved, it appears feasi-ble to plant yellow poplar soon after thinning, since yellow poplar main-tained fair growth and good survival on the lightly thinned plots after four seasons.

Table 2. — Percent of Total Hardwood Reproduction Represented by Each Hardwood Species With Varying Intensity of Pine Thinning

Hardwood species	Pine thinning intensity				
	Unthinned	Light	Medium	Heavy	All cut
	percent of total hardwood reproduction				
Hickory (*Carya* spp.).................	....	.9	.8	1.2	.9
Red oaks (*Quercus* spp.)...............	18.2	5.9	9.1	14.7	5.4
Cherry (*Prunus* spp.).................	2.9	18.1	16.2	21.9	33.6
Ash (*Fraxinus* spp.)...................	26.9	28.0	22.4	22.3	12.1
Elm (*Ulmus* spp.).....................	8.7	7.2	6.3	5.6	6.3
Hackberry (*Celtis occidentalis*)..........	....	....	.4	....	....
White oaks (*Quercus* spp.).............	.7	....	1.2	....	.9
Maple (*Acer* spp.)....................	....	.9	.4	....	....
Black walnut (*Juglans nigra*)...........	7.9	2.3	.4	.9	....
Sassafras (*Sassafras albidum*)..........	9.4	10.0	14.6	11.4	25.1
Persimmon (*Diospyros virginiana*)........	18.9	11.8	3.2	....	1.1
Flowering dogwood (*Cornus florida*)......	3.6	10.9	17.8	8.8	8.0
Hazelnut (*Corylus americana*)...........	....	....	2.0	....	....
Black locust (*Robinia pseudoacacia*)......	....	.9	2.0	11.1	5.4
Boxelder (*Acer negundo*)...............	.7	2.7	.8	2.1	.4
Hawthorn (*Crataegus* spp.)..............	....	....	.8	....	.2
Eastern redcedar (*Juniperus virginiana*)...	1.4	....	1.6	....	.2
Sumac (*Rhus* spp.)....................	17.0	.4	....	....	.4
Total	100.0	100.0	100.0	100.0	100.0

NEW APPLE STRAINS DEVELOPED

By Forcing Shoots on Disbudded Trees

D. F. DAYTON

Most of the bright red apples on the market today are produced from improved strains commonly called bud-sports. These strains develop a more intense color than the original variety, and a higher proportion of their fruits have satisfactory color. Some bud-sports develop color earlier in the season. A sport may also differ from the original variety in growth habit and tree vigor.

Such changes occur spontaneously and result from genetic mutations that occurred during the tree's growth. A changed character can be propagated asexually; thus the limb or tree showing the changed character can become a new strain.

How mutations occur

Red color (anthocyanin) in apples is produced principally in the outermost two cell layers of the skin. These cell layers are derived from a narrow band of cells near the outer surface of the twig or spur on which the fruit grows. Fruit color is therefore determined by the genetic factors carried in this narrow band of cells. If a gene mutation affecting red color production occurs in this band of cells on one twig, the fruit will differ in color from fruit on other limbs of the tree.

Genetic mutations are not necessarily confined to this narrow band of cells, but may be carried in any of the wood in a twig or shoot. The effect of mutant genes in the internal wood ordinarily is not apparent, however, being masked by the outer layers of tissue.

Forcing adventitious shoots

The technique of forcing adventitious shoots was used to test for genetic mutations in the internal wood of Golden Delicious, McIntosh, and several strains of Red Delicious. The trees were a year old, cut back to 18 inches in height, and were growing in large pots of soil. The buds were cut out and the trees were coated with a clear waterproofing material to keep the wood from drying. The numerous sprouts that developed from the roots were removed as soon as they appeared.

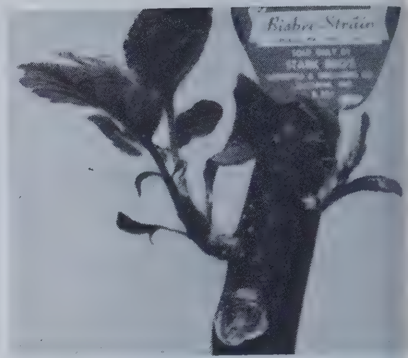
Disbudding young trees causes extensive cell division just underneath the outer bark. This leads to the development of spherical cell masses called *prosphaeroblasts.* A cell mass may harden into wood, or it may continue to enlarge and form a growing point which will push out through the bark and develop into a typical leafy shoot. This is called an *adventitious* shoot, since it developed at a location and from tissue not normally giving rise to such growth.

The shoot will carry the full genetic constitution of the internal tissue from which it developed. Mutant genes, if present, will no longer be masked by external cell layers. An adventitious shoot can be grown into a fruiting tree or propagated by the usual methods.

Disbudding had no effect on Golden Delicious, but one or more adventitious shoots formed on all the treated McIntosh and Red Delicious trees. After the shoots developed into young trees, they were planted in the orchard and grown for fruiting test.

Changes found

Of 25 trees developed from adventitious shoots, 15 exhibited fruit or tree characters more or less different from the source variety. Many of the changes were horticulturally undesirable, but they did materially aid in understanding the nature and



Adventitious shoots on disbudded tree.

development of bud-sports. Thr trees were selected for propagatic and further testing because of e cellent fruit color or desirable tr characters.

As an example of desirable chang adventitious trees of a striped-fru strain of McIntosh produced fru with a blushed pattern of pigme tation, a marked improvement. Tl striped McIntosh had been due to mutation in the narrow band external cells of the wood. Gen conditioning the original blush coloration of McIntosh were st carried in the internal layers, ho ever, and were recovered in t adventitious shoots.

The same type of phenomenon a counted for an undesirable chan in adventitious trees of Richare a bright red blushed strain of R Delicious. These trees produced pa striped fruit similar to the origir Delicious. This indicates that Ric ared's internal wood is relatively u changed and that its improved fru color is due to a mutation in t external cells.

Some adventitious trees develop from Redspur (a Delicious stra with the spur-type fruiting hab closely resembled the original De cious in growth and fruiting habit, b were semi-dwarf in vigor. Oth adventitious Redspur trees show almost no change.

These results demonstrate that ce may carry mutations affecting t or more characters, and that th internal wood may be heterogeneo containing two or more kinds f genetically different tissues.

D. F. Dayton is Professor of Plant Breeding, Department of Horticulture.

Some Uses of Radioactive Isotopes in Veterinary Medical Research

F. E. ROMACK

HE FRONTIERS of animal science must be pushed forward at an ver increasing rate to provide for orld population growth and to im- rove living standards. According to eliable estimates, over half of the nore than 2 billion people in the orld today do not get enough food or normal body function and main- nance. And the world's population ontinues to grow at the rate of about),000,000 individuals a year.

To keep food production in pace, iere must be increasing production om the land, and this advance must e based on research by plant and nimal scientists.

Plant and animal research is being mulated through the use of radio- tive isotopes. These new tools are mply atoms that emit radioactive articles. Most molecules that are ot naturally radioactive can be made by "tagging" them with a radio- tive atom. That is, the radioactive om is substituted for a naturally curring atom of the same element. his makes the molecule easy to ace in a plant or animal.

Radioactive isotopes are unlock- g the secrets of body maintenance, owth, and reproduction, and eluci- ting the scourges that hinder or stroy these processes. The hundreds potential uses are limited today ly by the availability of proper tection equipment, funds to pur- ase radioactive equipment, and ined research personnel.

Tracer studies of radioactive iso- es in animal nutrition and physi- gy are similar to those in plant ysiology. The problems and ap- oaches are also very similar to se involved in the use of isotopes studying human physiology and metabolism. The results of animal studies are often applied to human beings.

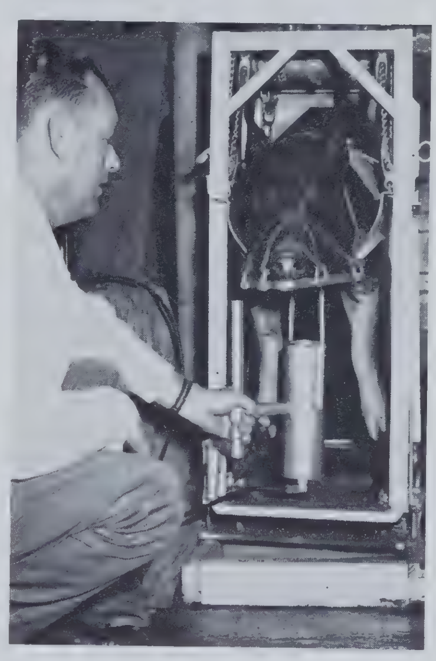
Radioisotopes are uniquely valu- able for studying the metabolism of minerals, particularly the extremely small quantities of the micronutri- ents. A good example is cobalt me- tabolism in the ruminant. Cattle and sheep require between 0.04 and 0.07 parts per million of cobalt in their diet, while simple-stomached animals require much less. Small quantities of cobalt are normally found in the molecular structure of vitamin B-12. so radiocobalt has proved valuable in this studies of this vitamin.

Molybdenum is another micronu- trient essential to animals. Studies of dairy cattle utilizing radiomolyb- denum have resulted in the isolation of an enzyme containing molybdenum from milk.

Radioactive sulfur 35 was utilized in studies of amino acid formation by sheep and cattle. It was also used in poultry nutrition studies, with a rather surprising result. This was the discovery that the amino acid, sulfur cystine, was formed from inor- ganic sulfur in poultry. Thus sulfur, which is known to be important in ruminant diets, may prove to be important in nonruminant diets as well.

Another use of radioactive sulfur is in the study of selenium poisoning on western ranges. The ingestion of selenium is believed to affect sulfur metabolism. Some evidence shows an interchange of sulfur and selenium in the formation of some amino acids.

Radioisotopes are invaluable in investigating the transfer of elements through the placenta to the develop- ing fetus. They permit detailed stud- ies of the effect of body size and multiple births (such as in swine) on placental permeability and the deposition of elements in the fetal skeleton, body tissues, and organs. Also, hormone secretion rates and the tissues where the hormones cause a physiological change in animal func- tion can be monitored through tag- ging techniques.



The author uses a dual ratemeter to measure levels of radioactivity in the thyroid gland of a hog injected with radioactive iodine (iodine-131). The ratemeter can record radioactivity in two sites within an animal at the same time.

Scientists have utilized gamma rays from radioisotopes to interfere with the reproduction cycle of certain insects. Sterilization of large numbers of male insects reduces the population of the next generation.

The use of radioactive insecticides and herbicides facilitates the study of the absorption and distribution of the toxicants, and thus aids in the battle against pollution of the environment.

·. Romack is Associate Professor of Veter- ·y Biological Structure.

STERILIZED WHIPPING CREAM

Experimental creams whip well, score high on taste tests, and retain their quality after a year of cold storage

H. K. WILSON

WHIPPED CREAM has for years enjoyed the reputation of being the tastiest and most attractive topping for deserts. Now this long-standing reputation is being challenged by synthetic, ready-to-serve frozen toppings and by dry powders to which only water or milk need be added to make a product that will whip at room temperatures.

Problems of whipping cream

As anyone who has whipped real cream knows, a certain number of precautions must be taken to make sure the cream whips properly. The cream must be cold and the bowl and beaters must be chilled. Shape of the bowl is important, as the cream must be deep enough, but not too deep. All parts of the cream should come into contact with the beaters, but beaters should not be completely covered. If the cream is too warm it may churn, and it may become too warm if it takes too long to whip.

The minimum fat content of whipping cream has been set by state law, and creams which meet the standards should whip properly provided that, after pasteurization, they have been chilled enough to give the fat a chance to solidify.

The proper processing of whipping creams has presented problems to milk dealers. The pasteurization temperature needs to be higher than for fluid milk to obtain the same keeping quality, and the processing must be controlled to avoid breaking the large fat globules. Freezing or excessive agitation of the milk before separation will result in broken fat globules, and a hard layer of non-globular fat will form on the surface of the cream. Pasteurized cream has limited keeping quality. Consequently creams which have been left unsold in grocery stores for a few days represent a loss to the processor.

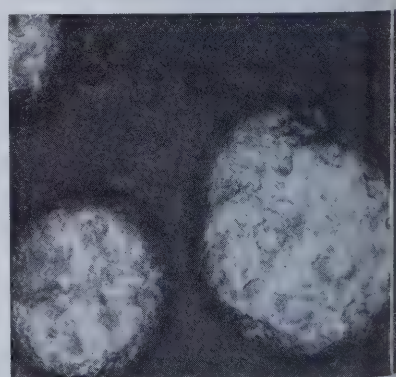
Sterilization of creams has extended the bacteriological keeping quality but at the same time has made other quality problems more prominent. Chemical changes may take place after sterilization with detrimental effects on flavor. One of the most obnoxious of the possible off-flavors is the oxidized taste which has been variously described as cardboardy, chalky, or tallowy. This flavor can be inhibited by adding small amounts of polyphosphates, milk solids not fat, and vitamins C and E. These compounds are found naturally in milk and they all have special nutritive values besides their ability to inhibit the undesirable oxidized flavors.

Other problems are associated with the characteristics and behavior of the fat globules. In fresh untreated milk these globules appear in a wide range of sizes. The smallest are as small as the fat globules in homogenized milk so that they tend to remain in suspension. The larger globules will rise rather quickly to form a cream layer on milk. Similarly, large globules will form a thickened layer on untreated cream.

Homogenization will keep the thick layer from forming on cream, but homogenized creams do not whip well. Although air bubbles can be incorporated into these creams by whipping, the result is like a foam that breaks down quickly and does not make an attractive serving. Homogenization does something to the cream that lessens its ability to hold air bubbles in suspension. Figure 1 shows air bubbles in whipped homogenized cream. Only the largest bubbles can be seen. The pictures could not be taken quickly enough to show the smaller bubbles that were present immediately after whipping.

Sterilized creams which have been offered for sale have contained thickeners or stabilizers to increase the viscosity and retard the rising of the large fat globules. Numerous compounds such as gums, alginates, starches, dextrines, and mono- and di-glycerides have been used for this purpose. There is always danger that these products, which are foreign to milk, may impart an undesirable flavor or other unwanted effects. Some of them may cause the cream to form a thick gel or the whey to separate from the rest of the cream. Starches and dextrines tend to lose their thickening power when subjected to the temperatures necessary for sterilization.

Figure 2 shows clusters of protein particles in cream to which one of the newer tasteless stabilizers was added before sterilization. (Magnification is 1,100 — more than six times as great as in the other illustrations.) The protein clusters increased vi-



Air bubbles in whipped homogenized cream containing 30 percent fat (magnified 175 times). Fat globules can be seen on the surface of the bubbles. (Fig. 1)

H. K. Wilson is Associate Professor of Dairy Technology, Department of Food Science. The work reported here was supported by a grant from the American Dairy Association.

›sity and the cream whipped well. owever, whey separated after the ream was whipped. Often whey ay be found in the container in hich this type of cream has been ›red.

‹perimental creams

In the Department of Food Science e have experimented with creams high fat content, adding milk lids-not-fat to increase viscosity and us retard the rise of the large fat obules. The viscosity of these ex-rimental creams has been great ough that they have needed to be inned with pasteurized milk before hipping.

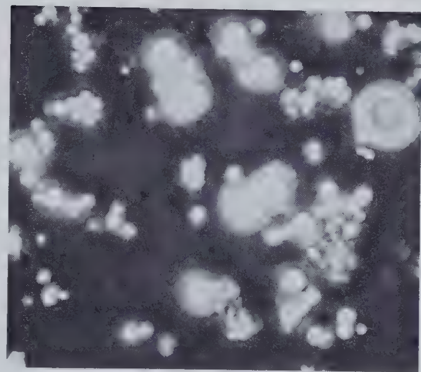
Figure 3 shows the air bubbles in scous cream whipped without the dition of milk; Figure 4 shows the bbles when milk was added before e cream was whipped. The volume the whipped cream with milk was out 1½ times that of the cream thout the milk. This difference in lume is about the same as the dif-ference in the size of the air bubbles.

The experimental creams have re-tned good body and flavor for more n 8 weeks, and many of them ve stayed good for more than a yr in cold but not frozen storage. ter 6 months' storage, a thickened er has usually formed on the sur-e of these creams, but the thick-ed layer has mixed readily with the lk and whipping times have been same as when the creams were sh. These whipped creams can be zen between layers of cake or in sed containers and retain the same d eating quality after frozen stor-as when freshly whipped.

reams of this type have not been red for sale. Without test market-there is no way of knowing ether consumers would pay the her prices that would be necessary ause of the higher fat content. nsumers do pay more for some of vegetable-fat synthetic toppings n for fresh whipping cream.

tes compared

taste test was made of the ex-mental cream and of various top-gs sold in local grocery stores.



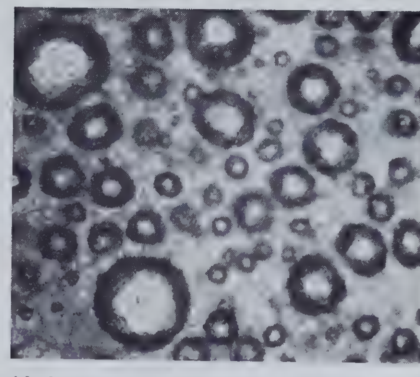
Clusters in cream containing 30 percent fat and added stabilizer (magnified 1,100 times). Whey separated from the body of the cream. Large fat globules have halos around them. (Fig. 2)

These included one pasteurized whip-ping cream, one sterilized cream, and eight different synthetic vegetable-fat toppings. Four of the synthetic prod-ucts were powders that required the addition of water or milk before whipping. Two were frozen whipped and ready to serve. Two were in gas pressurized cans, ready to serve when released from the cans. Each topping was prepared according to its own directions and placed in numbered but otherwise unmarked containers for evaluation by 13 persons, includ-ing secretaries, students, and labora-tory assistants.

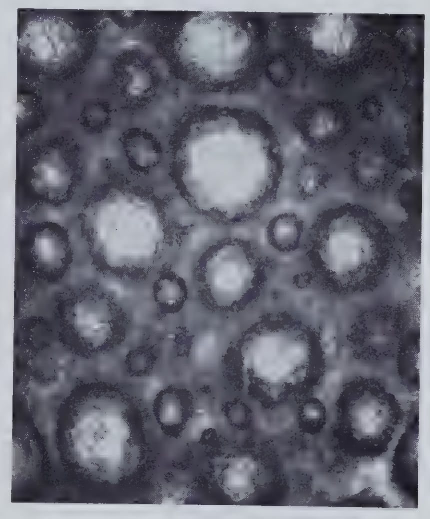
The whipped fresh pasteurized cream was rated best. One of our experimental sterilized creams was rated almost as high as the fresh cream but the purchased sterilized cream was criticized as having an undesirable flavor probably due to the type of stabilizer in it.

The synthetic toppings, except those in the gas pressurized cans, had very pleasing flavors but not the flavor expected of fresh pasteurized cream. Five of the eight synthetic toppings cost more than the fresh or sterilized cream for the same weight or volume of whipped cream.

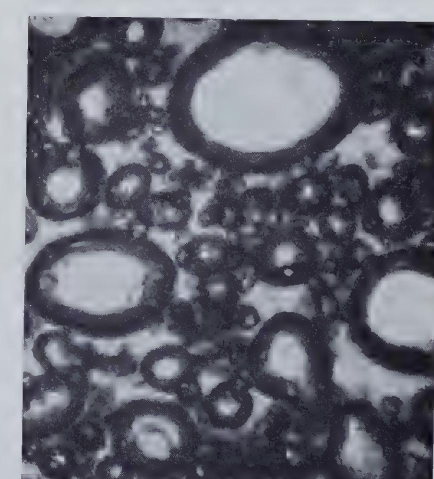
Figure 5 shows air bubbles in a frozen whipped topping. It is evident that this product contained sufficient stabilizers to hold the air bubbles in suspension. It contained a saturated vegetable fat that did not tend to soften at room temperature as does the fat of real cream.



Air bubbles in sterilized cream containing 44 percent fat, whipped without addition of milk. This picture, as well as Figures 4 and 5, is magnified 175 times. (Fig. 3)



Same cream as in Figure 3, whipped after addition of milk. (Fig. 4)



Air bubbles in frozen whipped topping containing hydrogenated (saturated) veg-etable fat. (Fig. 5)

Operating a Screw Conveyor With Minimum Damage to Corn

GLENN E. HALL and LARRY D. SANDS

THE SCREW CONVEYOR is one of the most useful and versatile devices involved in the movement of shelled corn on the farm. But it also has the reputation of being a major cause of grain damage.

According to recent laboratory tests, damage can be kept to a minimum by operating the conveyor at full capacity and by avoiding excessive auger speed. In addition to capacity and speed, other variables tested were inclination angle of the conveyor, air temperature used to dry corn, and moisture content of the corn.

The tests were conducted with corn that had been combined at about 24 percent moisture. It was then dried to 13 percent, except for some used in the moisture studies.

Equipment

A standard 6-inch screw conveyor with an overall length of 12 feet was used in the tests (Fig. 1). Since the openings at both the inlet and the outlet were 1 foot long, the actual tube length was only 10 feet. The conveyor flight was therefore considered to be 10 feet long when test results were analyzed.

The tube was 1/16 inch thick and the screw flight was 5 inches in diameter. There was thus a clearance of 7/16 inch between the tube and the flight when the flight was centered in the screw conveyor. The flight was supported by a bearing at the outlet end of the conveyor.

Two plywood bins were used to store the corn before and after it passed through the conveyor. A plywood gate metered out the corn at a steady flow. The bins had sloped floors so that they could be completely emptied. To minimize the damage to corn outside the screw conveyor, the bin floors were partially covered with rubber strips.

A cleaner, consisting of a screen supported by angle iron, was made to remove the fines from the corn (Fig. 1). The screen was ¼-inch hardware cloth with openings having an average width of 15/64 inch. Although official U.S. grain standards call for a sieve with round holes 12/64 inch in diameter, the ¼-inch hardware cloth was used because it would remove more of the broken kernels without letting any undamaged kernels fall through. An air vibrator, clamped to the frame of the screen, moved the kernels over the screen.

Procedure

Before corn was run through the conveyor, it was treated with a red dye. The dye colored only the exposed white surfaces of broken kernels. The surfaces of undamaged kernels remained yellow. Any kernels broken in the conveyor would have a white surface, making them easy to detect.

The dyed corn was put into a bin which discharged into the inlet of the conveyor. The corn was allowed to fill the inlet before the conveyor was started. The conveyor then discharged corn into the second, or upper, bin (Fig. 1). As soon as the bin at the inlet was empty, the conveyor was stopped, so that it would never operate below the desired capacity.

The empty bin was moved under the cleaner discharge, and the corn passed over the vibrating cleaner screen into the bin. A sample of corn was obtained at the discharge

Screw conveyor, grain bin, and vibrat cleaning screen used in tests. (Fig.

end of the cleaner, weighed, a examined for newly damaged k nels, including those that were sp cracked, or broken, or had ni which penetrated the seed coat a exposed the endosperm or germ. K nels were not considered damaged just the tip cap was missing.

The fines passing through t screen were collected in a pan un the cleaner and weighed. The n fines, which were white, were sort out by hand from the dyed fines a were weighed separately. All t fines were then mixed back with t corn in the bin, which had be moved into position over the in of the conveyor. The cycle was peated to simulate a longer scr conveyor.

Capacity and speed

The importance of keeping the co veyor full — or of reducing sp when the conveyor is not full — i illustrated in Figure 2. It shows percentages of fines produced w different auger speeds when the c veyor was operated at one-fourth a at full capacity. Auger inclinat was 50 degrees.

One-fourth capacity was obtai by covering about three-fourths the conveyor inlet so that it took f times as long to transfer a 500-po

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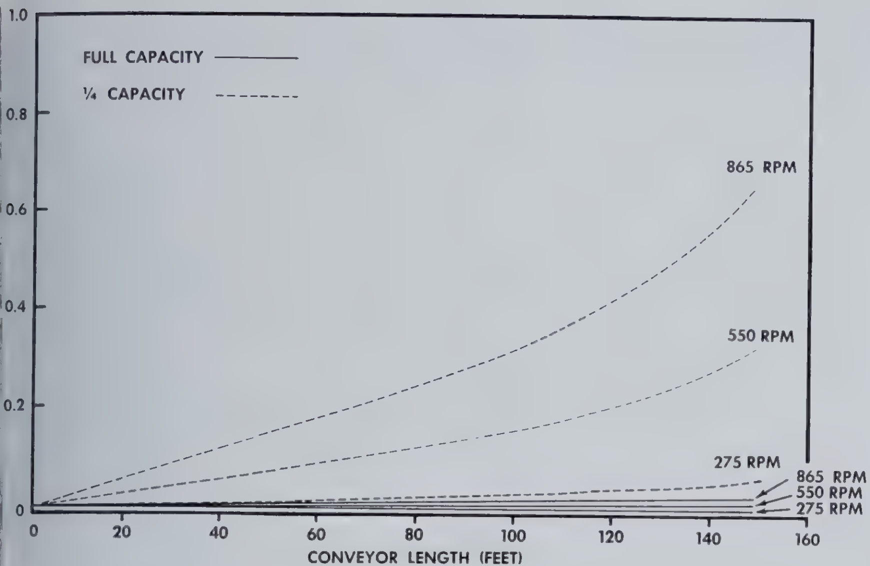
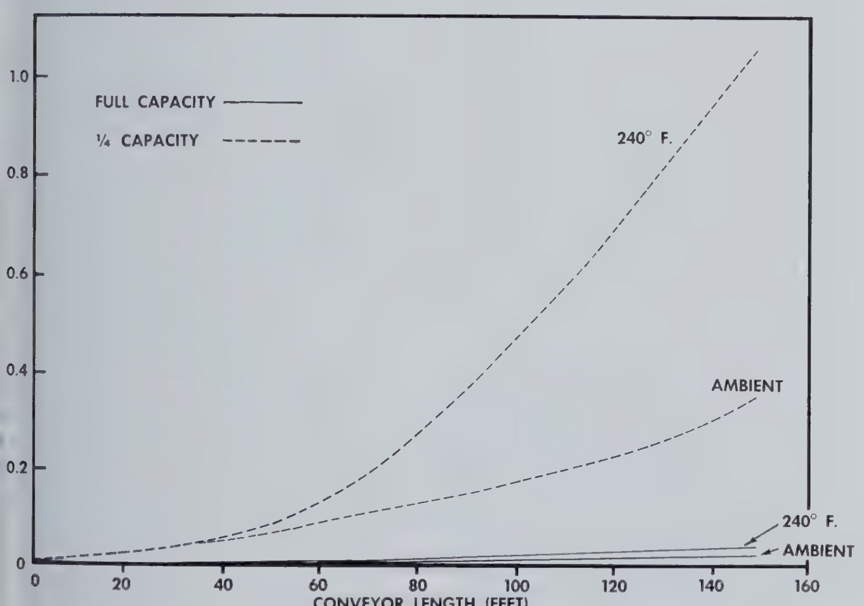
Glenn E. Hall is Assistant Professor of Agricultural Engineering; Larry D. Sands is a former student of agricultural engineering.



ines produced in shelled corn during transport at three speeds; conveyor operated at ll capacity and at one-forth capacity, with a 50-degree inclination. Corn had been ried to 13 percent moisture in ambient air. (Fig. 2)



ıes produced in shelled corn that had been dried to 13 percent moisture in ambient and in air heated to 240° F.; conveyor operated at full capacity and at one-fourth acity, with a 50-degree inclination and a speed of 550 rpm. (Fig. 3)

nple as when the inlet was open. ter the corn was run through 0 feet of conveyor at one-fourth pacity and a speed of 865 rpm, percent of the sample was broken o fines. This amount was reduced 0.35 percent at a speed of 550 rpm d about 0.08 percent at 275 rpm.

Operating the conveyor at full pacity reduced the number of es still more. Even at a speed of 865 rpm, fewer fines resulted than when the conveyor was operated at one-fourth capacity and 275 rpm.

The normal speed for this type of auger is about 550 rpm. At this speed about 35 bushels of fines would be produced when 10,000 bushels of 13-percent corn is transported through 150 feet of screw conveyor at a 50-degree auger inclination and at one-fourth capacity. At full capacity about 2 bushels of fines would be produced.

The number of damaged kernels produced, in addition to the fines, is shown in the table on this page.

Broken and Cracked Kernels With Different Auger Speeds, Drying Temperature, and Conveyor Capacity

Drying temperature	Auger speed, rpm	Capacity	Damaged kernels Pct.	Damaged kernels Bu. per 10,000 bu.
Ambient	275	¼	0.7	70
Ambient	550	¼	2.3	230
Ambient	865	¼	4.9	490
Ambient	275	Full	0.1	10
Ambient	550	Full	0.3	30
Ambient	865	Full	0.4	40
240° F.	550	¼	6.0	600
240° F.	550	Full	0.5	50

Drying temperatures

The damage done by operating the conveyor at one-fourth capacity was more than tripled when corn was dried at 240° F. rather than in ambient air. The percentages of fines in heat-dried and ambient-air-dried corn are shown in Figure 3. About 120 bushels of fines were produced per 10,000 bushels of corn dried at 240° F. and transported 150 feet at a speed of 550 rpm. As already mentioned, the comparable figure for corn dried in ambient air was 35 bushels. Very few fines were produced when the conveyor was operated at full capacity.

As shown in the table, the heat-dried corn had more broken kernels than the ambient-air-dried corn.

Inclination angle

Operating the conveyor in a horizontal position caused about one-fourth more fines than operating it at a 50-degree inclination. The percentage of damaged kernels was about the same for both positions.

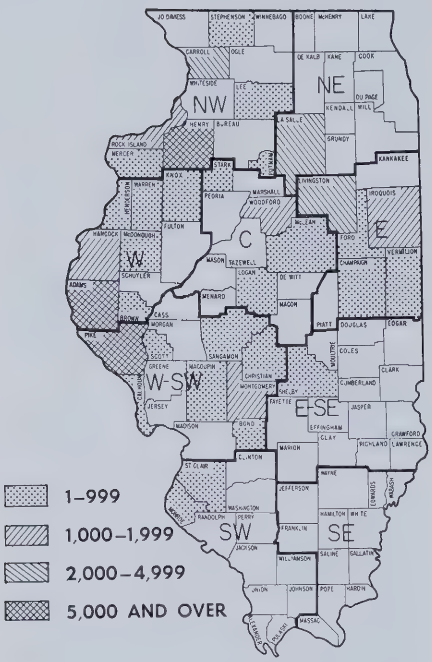
Corn moisture

A few tests were made with corn at various moisture contents. Corn with 22 percent moisture was damaged less than the more brittle 13-percent corn. Judging from several years' harvesting experience, optimum moisture content for minimum damage should be 20 to 24 percent.

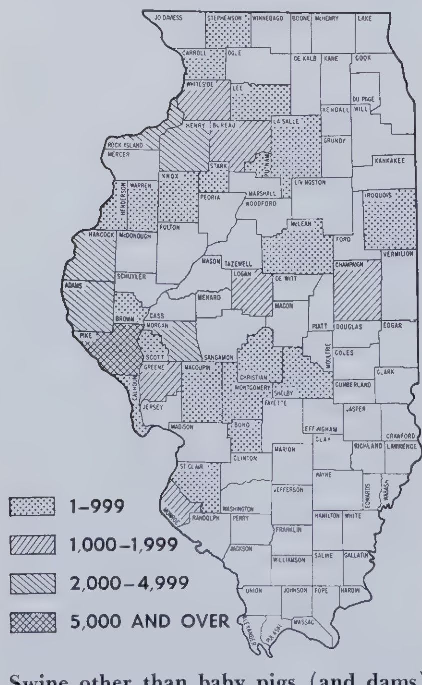
TRANSMISSIBLE GASTROENTERITIS OF SWINE:

Some Recent Patterns of Occurrence in Illinois

D. H. FERRIS



Baby pigs affected with TGE, 1968-69. Letters on map designate the regions referred to in the table. (Fig. 1)



Swine other than baby pigs (and dams) affected by TGE, 1968-69. (Fig. 2)

A HIGHLY contagious viral disease, transmissible swine gastroenteritis (TGE) is the major cause of large-scale gastroenteritis epizootics among swine in winter. It kills large numbers of baby pigs and also attacks older swine.

Because relatively little exact information was available about the spread and occurrence of TGE or about total losses, a five-year study of ecologic factors associated with gastroenteritis in swine was begun in 1968.

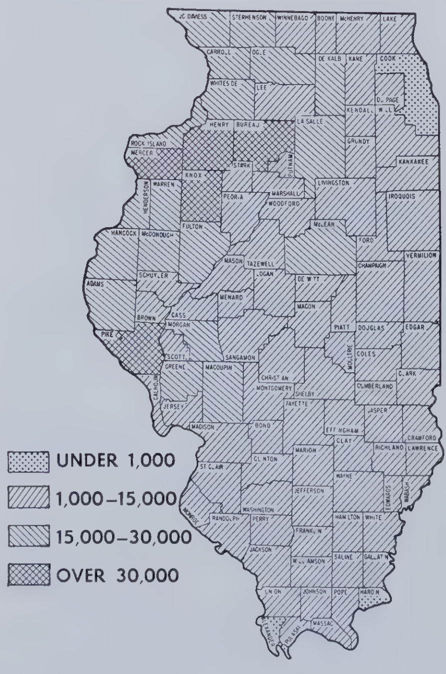
Postal card questionnaires were sent to all veterinarians with swine practice and to all pork producers. They were asked to complete and return the cards when an outbreak of gastroenteritis occurred in swine.

Upon receipt of a card from either producer or veterinarian, we mailed a longer and more detailed questionnaire to the owner of the diseased herd. It was to be filled out at th end of the outbreak. Both questio naires requested a veterinarian's d agnosis.

Since it was not possible to perfor serologic tests or do viral isolatio on swine from all farms, the reporte syndrome has been merely entitle a gastroenteritis. However, TGE w diagnosed in each instance by a vete inarian; the swine showed the class signs of the disease; and many bal pigs died. It is therefore a reaso able assumption that TGE was th disease in most of the outbreaks.

The value of using both questio naires is indicated by the table page 17, which compares the resu of the card questionnaires and of th combined questionnaires. Being ea to fill out and return, the card w an excellent means of obtaining in mediate information during the ep zootic. The longer questionnai contained more definitive data.

The final reports gave data 54,315 baby pigs, 8,605 dams, a 35,196 other swine on 242 farms 34 counties. Overall baby pig mo tality averaged 41 percent and mo bidity, 56 percent. Of the dams, percent were sick and 25 died. even higher proportion of other swi (81 percent) were affected.



Number of breeding swine in the state, 1968. (Fig. 3)

Geographic and time patterns

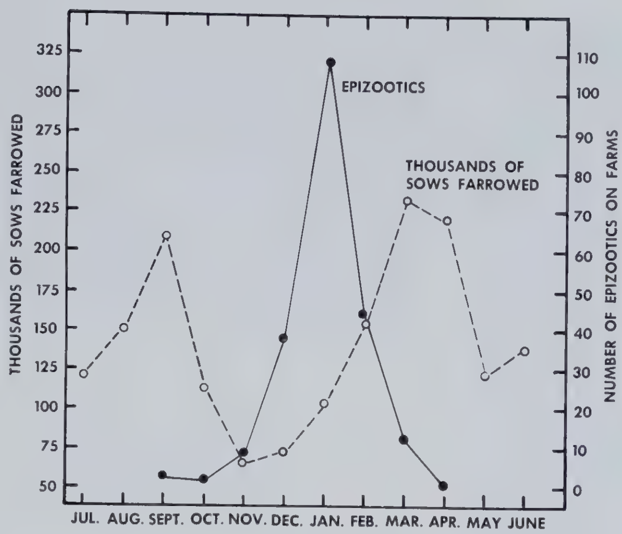
The numbers of baby pigs and other swine affected in each coun during the winter of 1968-69 a shown in Figures 1 and 2. The maps should be studied in conjun tion with Figure 3, which shows t concentration of swine in each coun Although losses tended to be relat to numbers of swine, the correlati was not perfect. Carroll and O counties had about the same co centration of swine, for example, b losses were reported only from Ca roll County.

One of the most interesting as-
ects of the study has been to clar-
y the relationship between gastro-
nteritis outbreaks and the seasonal
hanges in swine population. E. O.
laelterman, in his classic study of
'GE epidemiology (published in
962), placed the peak of the sea-
onal occurrence in March. This co-
icided with the spring farrowing,
hen swine population is usually
its highest.

Although the same diagnostic cri-
ria used by Haelterman were util-
ed in this study, the peak of out-
eaks was found to be in the lowest
rt of the population cycle, between
e fall and spring farrowings (Fig.
. Thus, the seasonal pattern may
ve changed since it was described
Haelterman. However, the rela-
nship of TGE outbreaks to cold
eather, as observed by Haelterman
d others, was confirmed.

The first reported outbreaks ap-
ared almost simultaneously in the
rthwestern counties of Whiteside
d Bureau and the southwestern
unty of Montgomery in September.
e outbreak in the eastern county of
Salle was reported in October,
th six in the northwestern counties
Lee and Henry and one in the
thwestern county of Bond in No-
mber. Outbreaks appeared simul-
eously in the counties shown in
gures 1 and 2 during December,
nuary, and February. There was
apparent movement of virus from
section of the state to another,
hough foci could be noted in some
ions.

Evidence that the disease does
often strike the same farm two
rs in a row was obtained in the
dy, supporting previous observa-
ns. Of the producers reporting



Monthly pattern of TGE outbreaks on Illinois farms, 1968-69, as compared with pattern of sow farrowings (1960-1968 median). (Fig. 4)

Reported Morbidity and Mortality From Gastroenteritis in Illinois Baby Pigs

Region of state	Card questionnaire				Combined questionnaires			
	No. of farms	Total pigs	Pct. sick[a]	Pct. died	No. of farms	Total pigs	Pct. sick[a]	Pct. died
Northwest	34	9,184	50	15	61	17,011	60	35
Northeast	9	1,800	60	10	9	2,543	85	14
West.....	56	7,611	18	65	56	11,802	59	41
Central......... ...	6	1,777	82	18	12	2,763	59	37
East..............	13	3,331	55	19	14	5,348	71	29
West-Southwest.....	40	6,718	52	42	54	13,954	38	60
East-Southeast......	0	0	..	..	1	110	85	15
Southwest	3	567	79	17	5	1,184	24	29
Total or Ave.	161	31,088	65%	35%	212	54,315	56%	41%

[a] Defined as those which were sick but survived.

outbreaks in 1968-69, only ten reported having had an outbreak the previous year. Only three others reported outbreaks in any other two consecutive years.

Type of swine affected

The susceptibility of baby pigs and their dams to the disease was obvious from the high morbidity in both, as well as the high mortality in baby pigs. However, baby pigs were the first swine to become sick on only four of the farms where other swine were present. The disease struck fat hogs first on 51 of the farms; pregnant gilts and sows on 39 farms. Usually baby pigs and their dams were the last to get sick.

The most significant statistic in connection with TGE is mortality in baby pigs, which is often described as close to 100 percent. Although some farms lost nearly all their baby pigs, losses were not universally this high. Baby pig mortality varied from 35 percent in the northwest to 60 percent in the southwest.

It was apparent from the letters sent in with the reports that supportive treatment reduced death and weight losses. A few farmers reported using capsule vaccines. Since TGE did not strike producers two years in a row very often, it is difficult to evaluate results of the vaccines.

Future plans

It is planned to continue this study on a national scale. We hope that study of ecologic patterns of the disease over several years will yield significant clues as to the importance of wildlife, common carriers, management practices, and perhaps other factors in causing the disease.

H. Ferris is Associate Professor of Veter-
y Pathology and Hygiene and of Veter-
y Research. He was aided in this study
Paul Doby, Superintendent of the State
sion of Livestock Industry; Paul R. Schnur-
erger, Assistant Epidemiologist, State of
ois; Charles Bloomberg, Executive Vice-
dent, Illinois Pork Producers Association;
. Mitchell, President, National Hog Farm-
Association; county Extension advisers in
ulture; many veterinarians; and by H.
Becker, J. R. Pickard, M. Ristic, and Al
in of the College of Veterinary Medicine.

INDIA'S "GREEN REVOLUTION" — Some Implications for U.S. Farmers

R. W. HERDT

EVER SINCE India's "green revolution" began about two years ago, agricultural experts around the world have been talking about the phenomenal increase in that country's food output.

How much will U.S. agricultural exports be reduced as a result of India's expanding productivity? Between 1965 and 1968, our total agricultural exports equaled about 20 percent of the value of farm production. A large proportion of these exports consisted of wheat and milo shipped to India, most of it under Title 1 of Public Law 480, but some as commercial sales.

The future trend of our exports to India is suggested by current research on the past and probable future course of Indian agriculture.

Trends in production and demand

Since the early 1950's, Indian agricultural production has followed a generally upward trend. By 1954, the production of foodgrains (which make up nearly 70 percent of the average diet in India) reached 72.3 million metric tons. This level was not exceeded until 1959, when production reached 77.1 million tons. After hovering near the 80 million mark for the next 5 years, it shot up to 88.9 million tons in 1965. In 1968 it reached 95.6, and in 1970 is expected to reach 103 million tons. Severe drouths occurred in 1966 and 1967, however, and the Indian government drew very heavily on P.L. 480 grain to avert widespread starvation.

Although the increase in food production averaged 2.5 percent a year between 1961 and 1969, it barely kept pace with annual population growth, which reached 2.5 percent in 1966. Food demand has been further increased by an annual growth of about 3.2 percent in per capita income between 1961 and 1969. With an income elasticity of 0.7 for food grains, the growth in income added 2.2 percent a year to the demand resulting from population growth. Total demand for foodgrains thus increased by about 4.7 percent a year between 1961 and 1969. Prices began rising substantially in 1964, although the authorities have tempered this rise by selling P.L. 480 grain at controlled prices.

Undoubtedly the food situation in India would have been much more serious, especially in short crop years, without imported grain. Some years about half of the wheat consumed in India has been imported.

Despite the failure of production to keep up with demand, the annual growth rate of 2.5 percent is substantial compared with the stagnation in foodgrain production during the first half of the century. It also compares favorably with the 2.2 percent annual increase in food output that occurred in the United States from 1935 to 1960, when production was expanding most rapidly in this country.

How production was increased

India achieved this progress both by increasing the area under cultivation and by increasing yields on land already in production. Land reform in the early 1950's helped to bring extensively used land into more intensive production. Programs to educate the villagers in modern practices of health, sanitation, local government, and agriculture had some impact on production. The amount of irrigated land, which yields substantially more than unirrigated land, was increased by nearly 20 million acres. And fertilizer use rose from 60,000 to 600,000 metric tons between 1953 and 1965.

By the early 1960's, however, polic makers in India began to realize tha for continued increases in productio something new must be introduce into Indian agriculture. Luckily som thing new was available in the agr cultural research programs underwa both in India and in other countrie

Research in India led to new higl yielding hybrid corn, sorghums, an millets. In Taiwan and at the Inte national Rice Research Institute the Philippines and in India, scientis developed distinctly new varieties rice. These varieties are much short than the traditional rice and so ca utilize higher rates of fertilizer to pr duce much higher yields witho undue vegetative growth and lodgin Since these new rice plants are n sensitive to day length, they can grown at a wide range of latitudes.

At the same time new wheat var eties were being developed in tl state of Washington and in Mexic Like the new rice varieties, the ne wheat plants are short, highly respo sive to fertilizers, and not sensiti to day length. None of the new whe or rice varieties are hybrids, so se production is simple.

The new wheat and rice variet proved well adapted to India experimental trials in 1966. As a r sult, the Indian government pr claimed a "new strategy" of fo production: To obtain the faste increase in the shortest time, fert izers and seed of the new variets were made available to irrigated are first. The success of that strategy reflected in the record production 1968 and 1969. The Indian gover ment has now set a goal of bei self-sufficient in foodgrains by 197

Some imports still necessary

Apparently, if this goal is reach India will no longer need to imp grains. To what extent is this true

Between 1957 and 1965, India i ported an average of 3.8 milli metric tons of grain a year from United States. This rose to 8.3 n lion tons in 1966 and 6.3 million t in 1967 as the result of drouths.

R. W. Herdt is Assistant Professor of A cultural Economics.

ustomers ride in from distant fields on a wagon.

Customers checking out.

Pick-Your-Own" — A Successful Method of Marketing Strawberries

W. COURTER, C. C. ZYCH, and H. A. CATE

USTOMERS like to pick their own strawberries. They'll drive a ndred miles to do it and bring eir families for a farm outing. They t fresh, high-quality fruit at fair ices.

Last year the customers on nine awberry farms were asked to fill t questionnaires about their expences and reactions. About 1,900 estionnaires were distributed and 4 (about 35 percent) were filled t and returned.

Three-fourths of the respondents licated that "quality of produce" s what they liked best about "pick-your-own." Nearly two-thirds said they liked the price. Many indicated that they wanted to pick other fruits and vegetables as well as strawberries.

The questionnaires did not ask the amount of strawberries picked by each customer. However, sales averaged 16 quarts per customer on one of the farms in the survey and 24 quarts on another farm. The largest single sale was 177 quarts.

More and more growers are expected to use this marketing method as the costs of labor, containers, and shipping rise. A location on good roads near population centers is important. Nearly 80 percent of the customers surveyed lived within 50 miles of the farm, and 55 percent lived closer than 25 miles.

Pick-your-own marketing can help improve farm-urban understanding. Urban people become better acquainted with farm families and modern methods of food production. Satisfied customers can become goodwill ambassadors for agriculture.

Certainly the idea of pick-your-own is not new. Not only strawberries, but also peaches and apples, have been sold this way for many years. With the renewed interest in pick-your-own marketing, we predict a bright future for pick-your-own fruits and vegetables in Illinois.

"Survey of 'Pick-Your-Own' Strawberry Customers, 1969," Fruit Growing No. 24, is available from the Horticulture Department, 124 Mumford Hall, Urbana, Illinois 61801.

/. Courter is Assistant Professor of Horticul-; C. C. Zych, Associate Professor of ticulture; and H. A. Cate, Associate Profes- of Agricultural Extension.

lia's "green revolution" (conc.)

i8, when production reached an time high, India still imported 4.3 lion tons of grain from the United tes.

)emand for food grains will prob- continue to expand by about 4.5 cent a year for the next 5 to 10 rs, after which the increase will down slightly as population con- becomes effective. Along with increasing annual demand, India plans to build a 5-million ton "buffer stock" by 1974. This will be used to alleviate localized food shortages due to unfavorable weather. At least part of this stock will come from imports.

To meet all the requirements in India, foodgrain production must increase by about 5 million tons a year in the near future and by about 6 million tons by 1975. This rate of increase is possible with the new varieties and fertilizer now available. However, this rate of growth without fluctuations would be a departure from the past pattern in India. Although increased irrigation will make Indian agriculture less dependent on uncertain monsoon rains, it appears likely that for the foreseeable future India will continue to import U.S. grain in drouth years. Thus, India will not be a regular recipient of foodgrains as in the past, but will import substantial quantities at irregular intervals during the next decade.

FARM BUSINESS TRENDS

During the past 15 years U.S. farm operating costs (production expenses) increased from $21.6 billion to $38.6 billion, or 79 percent. During the same time, average prices received by farmers for their products increased only 13 percent.

In order to meet the increased production expense farmers adopted many practices to hold down costs. Some of these practices have been combined to produce higher yields per acre, thus spreading costs over more bushels (or other units of production).

Looking ahead, farm production costs seem sure to continue their upward climb, at least as fast as during the past 15 years. It is not so certain, however, that farmers can increase crop yields as rapidly as they have been doing.

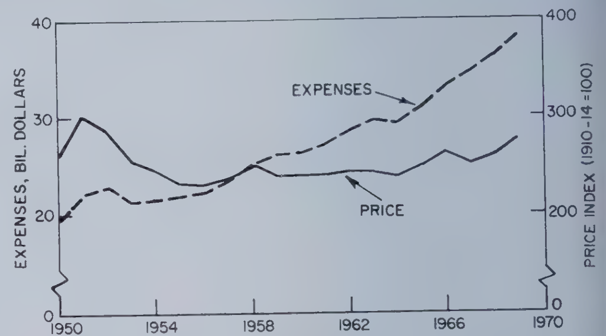
Consider the nation's principal crop — corn. In 15 years the 5-year U.S. average yield was increased from 39.4 bushels per acre to 77.4 bushels — an increase of 38 bushels, or 96 percent. In Illinois, the average acre yield increased from 53.2 bushels to 92.2 bushels — again comparing the latest 5-year average with that of 15 years earlier. The increase in yield was 39 bushels — but only 73 percent.

There are some indications that corn yields per acre are not going up so fast as they were, say 10 years ago. Recent increases in state and national averages reflect a catching-up with the leaders by the average farmers. Possibly water and sunlight — rather than plant population and fertilizers — are becoming limiting factors.

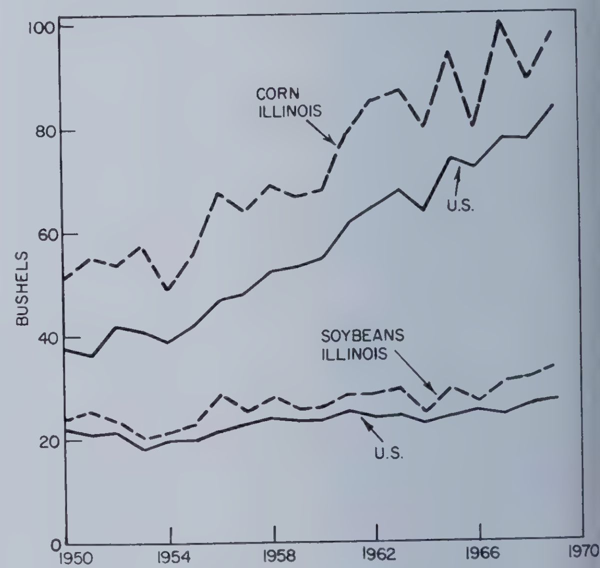
Soybean yields show somewhat different patterns. Over the 15-year period the 5-year U.S. average yield increased from 20.3 bushels per acre to 25.7 bushels — 27 percent. The Illinois state average increased from 23.1 bushels to 30.5 bushels — 32 percent.

New national average yield records were set in each of the past two years. New Illinois records were set in each of the past three years. In 1969 many farmers reported yields over 40 bushels.

In summary, during the past 15 years corn producers met rising production expenses by increasing average yields per acre. Farmers were not so successful in boosting soybean yields. In the future, the expected increases in costs may not be matched by higher acre yields. — *L. H. Simerl, Extension Economist*



Production expenses and index of prices received by U.S. farmers, 1950-1969.



Average yields per harvested acre of corn and soybeans, Illinois and United States, 1950-1969.

UNIVERSITY OF ILLINOIS · AGRICULTURAL EXPERIMENT STATION
Urbana, Ill. 61801 · G. W. Salisbury, Director · Publication · 12M

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Summer, 1970

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Finishing potato chips with microwave energy prevents overbrowning (page 12).

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE Volume 12, Number 3

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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G. W. Salisbury....................Director

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COLLEGE HISTORY PUBLISHED

WHEN EUGENE DAVENPORT arrived in Urbana on January 1895, to become the second dean of the College of Agricultur he found that "everything salable in the way of equipment ha been sold and the farm rented. . . . Fences were dilapidated, gat askew, and the few animals so plastered with mud that the colo were barely discernible. In defense the hostler argued that he w waiting for a curry comb. The house in which the Dean was su posed to live was in a sad state of disrepair. The sum of $60.(was provided for the operation of the College till the end of tl year."

During the 27 years since the University's founding in 186 agriculture (first as a department, then as a college) had struggl against apathy and sometimes downright enmity from the people the state, a lack of funds, and, perhaps most seriously, the lack of true agricultural science. After the Agricultural Experiment Stati was established in 1888, however, its staff members began diligent working to develop such a science, conducting over 100 experimer during the Station's first two years of operation. As a result, t Station soon commanded the farmers' respect and paved the w for the College's later strength and influence.

Both the early struggles and the vitalization of the College Agriculture under Davenport and later deans are engrossingly tc in *Fields of Rich Toil, the Development of the University of Illin College of Agriculture,* by Richard Gordon Moores (University Illinois Press). Building his story around the early leaders of t College — their personalities, their strengths, and their weaknes — Professor Moores has made the early days come alive for t modern reader. A liberal use of illustrations enhances the boo interest.

The book is available from the University of Illinois Press a cost of $6.95 plus tax. Alumni, students, and staff of the College Agriculture may obtain it at a special price of $5.00 plus tax ($5.2 by writing to ILLINOIS RESEARCH.

Increasing the Yields of High-Protein Wheat

D. P. HUCKLESBY, C. M. BROWN, and R. H. HAGEMAN

Inorganic nitrogen can increase grain yields and protein content of stiff-strawed varieties without adding to environment pollution

HUMAN HUNGER from shortage of food exists throughout the world.]alnutrition due to a low-quality ɛt is even more common, occurring i many areas where food supplies are equate to meet caloric requirements. A common cause of malnutrition i shortage of high-quality protein. ;ice wheat and other cereals provide e-half of the world's calories and e-third of the world's protein, any rease in the productivity and qual- of these crops may have far- ıching importance.

In the past, applying high rates of ırogen fertilizer to wheat has rarely ıreased both grain yield and pro- ı content. Increased plant growth ı; often caused lodging. When ıher yields have been obtained, the ɔtein content of the grain has usu- ı declined.

3oth of these difficulties may soon › overcome, according to a study ɛently made on the University farm. [e use of new stiff-strawed varieties]t resist lodging should make higher ıplication rates of nitrogen feasible, ıile proper timing of nitrogen appli- ıions will probably maintain protein ı tent.

Unfortunately nitrogen fertilizers ıich are converted to nitrates in ı soil) contribute to water pollu- ı under certain conditions. This ıcle suggests that sound principles ınanagement will help to avoid the ɛtamination of our streams, lakes, ı reservoirs with soil nitrates.

·ieties and treatments

Three stiff-strawed varieties of red ·ter wheat (*Triticum aestivum* L.) ·e used in the study — the two soft ɛeties Arthur and Blueboy; and the ɛl variety, Parker.

Arthur, developed in Indiana, has ı the highest yielding soft winter ·at variety adapted to the Mid-west. Blueboy is a semidwarf variety from North Carolina. Parker is a medium-height variety developed in Kansas.

Arthur matures the earliest of the three varieties. Parker matures 2 or 3 days later than Arthur, and Blueboy matures 7 to 10 days later than Parker. Of the three, Parker is the most susceptible to lodging.

The wheat was planted October 7, 1968, on Catlin and Saybrook silt loams. No fertilizer had been applied after removal of the previous oat crop.

Each plot was 18 feet long and consisted of 6 rows, 8 inches apart. Three plots of each variety were left untreated as controls. Potassium nitrate, dampened with a minimum amount of water to increase its absorption by the soil, was applied to the surface of the other plots. Two levels of nitrogen (50 and 100 pounds per acre) were applied on three dates: April 2, April 23, and May 9, 1969. In addition, a 200-pound treatment was applied on April 23. These treatments were replicated three times for each variety.

Increases in yield

All nitrogen treatments increased yield as compared with the control (0 nitrogen) treatment (Table 1). Increases were significant with one exception (50 pounds of nitrogen per acre applied to Arthur May 9). The 1969 season was ideal for wheat production and lodging was minimal.

Maximum grain yield was achieved on the Blueboy plots receiving 100 pounds of nitrogen on May 9. The yield of 102 bushels per acre was a record for the University farm. The fact that Arthur and Parker did not respond so well as Blueboy to late applications of nitrogen is explainable by their earlier maturity dates.

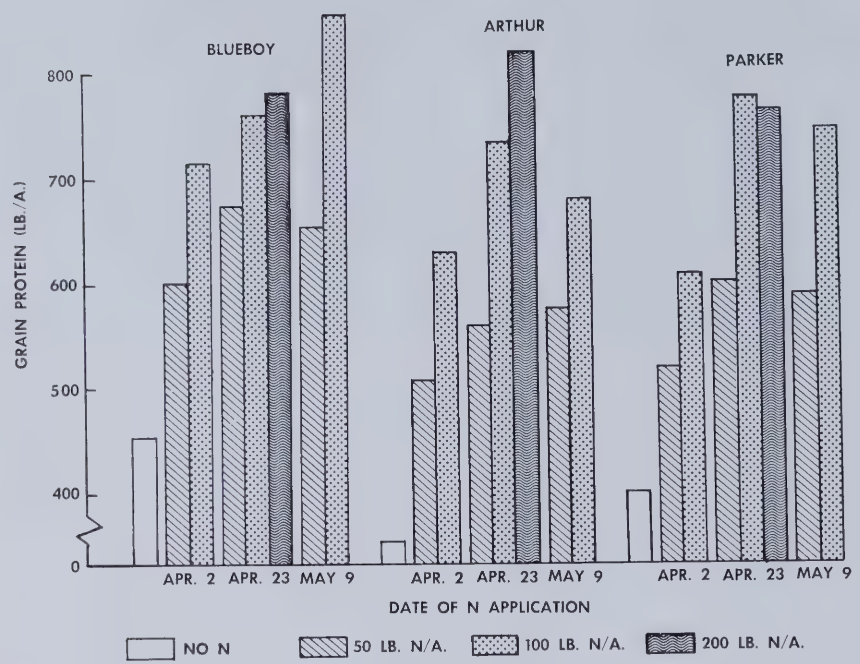
Both Blueboy and Parker responded less well to the April 23 application of 200 pounds of nitrogen than to the application of 100 pounds. This was not due to lodging, but may have been due to genetic-environmental effects on metabolism.

The yield increases were accompanied by increases in protein percentages (Table 1). These results contrast with the negative correla-

Table 1. — Effect of Spring Nitrogen Applications on Yield and Protein Percentage of Wheat Grain

Variety and date of treatment	Rate of N, lb./A. 0	50	100	200
	Yield, bu./A.			
Blueboy				
Control	75	..	..	..
April 2	..	87	92	..
April 23	..	98	92	85
May 9	..	91	102	..
Arthur				
Control	61	..	..	..
April 2	..	71	72	..
April 23	..	71	79	82
May 9	..	63	67	..
Parker				
Control	61	..	..	..
April 2	..	71	72	..
April 23	..	78	83	69
May 9	..	68	72	..
	Grain protein, pct.			
Blueboy				
Control	10.0	..	..	..
April 2	..	11.3	12.9	..
April 23	..	11.5	13.8	15.3
May 9	..	12.0	14.3	..
Arthur				
Control	10.4	..	..	..
April 2	..	12.0	14.6	..
April 23	..	13.2	15.4	16.9
May 9	..	14.6	16.9	..
Parker				
Control	11.0	..	..	..
April 2	..	12.2	14.2	..
April 23	..	12.9	15.6	18.6
May 9	..	14.5	17.2	..

D. P. Hucklesby is Visiting Research Associate in Agronomy; C. M. Brown, Professor of Plant Breeding; and R. H. Hageman, Professor of Plant Physiology.



Effect of spring applications of potassium nitrate on the production of grain protein per acre. (Protein measured as Kjeldahl-N × 5.70.) The value for the Arthur control plots is 376 pounds of protein per acre.

tions between yield and protein content commonly found in the past. Both amount and timing of nitrogen applications account for the increased protein percentages.

The maximum increase in total protein production was on the Arthur plots receiving 200 pounds of nitrogen per acre on April 23 (see chart). The increase on these plots, as compared with the control plots, was 117 percent. The minimum increase was 29 percent (Parker, 50 pounds nitrogen applied April 2). Average increase for all varieties and all nitrogen treatments was 63 percent. Producing this extra protein cost only \$2.50 to \$10.00 per acre.

We do not yet know how the soil-applied nitrate affected the quality of protein. However, samples of these wheats are being tested at two quality evaluation centers. Regardless of the results, these grains can be milled, analyzed, and fortified into reasonably priced high-quality food or feed.

Nitrogen taken from soil

The amounts of nitrogen that must be supplied by the soil to produce the straw and grain are emphasized in Table 2. Under normal production practices the straw is returned to the soil, so the grain nitrogen represents the approximate amount of nitrogen that must be added to the soil to maintain its productivity.

Removal of the grain caused a net decrease in soil nitrogen not only on the control plots but also on the plots that received 50 and 100 pounds of nitrogen. Only when nitrogen was applied at the highest rate (200 pounds per acre) was there a net gain in soil nitrogen (Table 3). This rate also gave less than maximum grain yield for two of the three varieties. We believe that the high recovery of nitrogen in this experiment was due to the application of nitrogen after the root system was well developed, and to the heavy soil type and the minimal rainfall during the 1969 season.

According to this study, inorganic nitrogen can be used to increase yields of high-protein wheat without inevitably adding to environment pollution. What is necessary is to grow stiff-strawed varieties that resist lodging, and to be accurate in the timing and amount of nitrogen applications. The nitrogen input in the soil should be closely balanced with the amount harvested in the grain.

Table 2. — Effect of Spring Nitroge Application on Nitrogen Content of Straw and Grain at Harvest

Variety and date of treatment	Rate of N, lb./A. 0	50	100	200
	N in straw and grain, lb./			
Blueboy				
Control	90	...	...	...
April 2	..	138	178	...
April 23	..	157	188	203
May 9	..	142	193	...
Arthur				
Control	84	...	...	...
April 2	..	114	149	...
April 23	..	123	163	185
May 9	..	127	157	...
Parker				
Control	95	...	...	...
April 2	..	121	145	...
April 23	..	142	177	191
May 9	..	130	171	...
	N in straw, lb./A.			
Blueboy				
Control	18	..	..	..
April 2	..	33	52	..
April 23	..	38	53	65
May 9	..	27	39	..
Arthur				
Control	18	..	..	..
April 2	..	24	38	..
April 23	..	25	34	41
May 9	..	29	37	..
Parker				
Control	24	..	..	..
April 2	..	29	38	..
April 23	..	36	40	5[illegible]
May 9	..	27	40	..

Table 3. — Net Change in Soil Nitr gen Estimated From Nitrogen Conte of Grain Removed[a]

Variety and date of treatment	Rate of N, lb./A. 0	50	100	20[illegible]
	Change in soil N, lb./A.			
Blueboy				
Control	−72	..	..	.
April 2	..	−55	−26	.
April 23	..	−69	−35	+6
May 9	..	−65	−54	.
Arthur				
Control	−66	..	..	.
April 2	..	−40	−11	.
April 23	..	−48	−29	+5
May 9	..	−48	−20	.
Parker				
Control	−71	..	..	.
April 2	..	−42	− 7	.
April 23	..	−56	−37	+6
May 9	..	−53	−31	.

[a] EXAMPLE: The grain produced by the con treatment (0 nitrogen) for Blueboy contained ab 72 pounds of nitrogen per acre. Grain produced the April 2 treatment of 50 pounds of nitrogen c tained about 105 pounds of nitrogen per acre. Si 50 pounds of nitrogen was applied, the net cha (value in the table) was about —55 pounds per a

Shelving From Wood Particleboard

POO CHOW

HE NEWEST of the wood-panel products, particleboard is a mixture f wood particles and synthetic resin ıat has been heated and bonded nder pressure. Because of its availbility, good dimensional stability, and ›w cost, it is a promising material ›r a variety of shelving.

Since particleboard does not have ıe high bending strength of solid ·ood, shelving designs used for solid ·ood cannot be used for particle›ard without modification. The ›ans suggested for solid wood need › be shortened if particleboard shelvıg is to support a load without ›nding too much or breaking.

Information is needed on two types bending. The initial "elastic de›ction" or bend is noticed immediely. Additional bending, called eep or sag deflection, occurs gradually over a long period. This type of ›nding has often been ignored by elving designers.

vo kinds of tests

Bending tests were conducted on ree types of shelving materials: a ›ain commercial particleboard; par·leboard covered on both faces with ·alnut veneer 1/36 inch thick; and ›aight-grained walnut. All materials ›re about 3/4 inch thick.

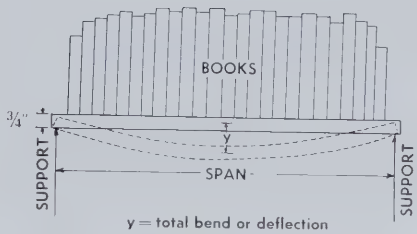
Short-term bending tests were made initial elastic deflection. For tests long-term creep deflection, speci›ns were loaded for 4 weeks with ›ree levels of "book loads": 17 ›unds (light load), 51 pounds (me›um load), and 102 pounds (heavy ›ad). The shelves were 12 x 32 i·hes. All creep or sag tests were ›rformed at a room temperature 70° F. and 65 percent relative ›midity.

›st results

In the short-term bending tests, the ·lnut was more than three times as ›f as the plain particleboard, and more than two times as stiff as the walnut-veneered particleboard.

Results of the 4-week creep tests were expressed as the ratio of total deflection to the elastic or "safe" deflection. The highest average creep ratio — 1.8 — was obtained for the plain particleboard. A thin veneer overlay greatly stiffened the particleboard, reducing the creep ratio to 1.4. The ratio for the solid walnut was 1.2.

These tests results were used in preparing the table above, which shows recommended spans under the conditions illustrated in Figure 1.

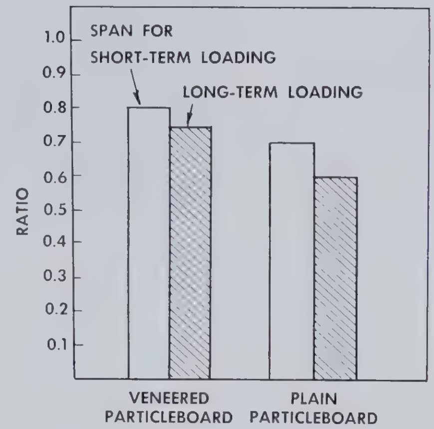


Long-term loading conditions on which the recommendations in the following table are based. The shelf is assumed to be 12 inches wide, 3/4 inch thick, and carrying a uniform load of books. (Fig. 1)

Recommended Spans for Shelving 12 Inches Wide and 3/4 Inch Thick[a]

Uniform load, lb./ft. of length	Particleboard[b] Plain	Particleboard[b] Walnut veneered	Solid walnut[c]
Max. distance between supports, in.			
10	48	56	68
20	39	45	57
30	34	39	47
40	31	35	43
60	27	31	38
80	24	28	34
Creep factor for span[d]			
Factor	0.80	0.85	0.90

[a] Recommendations permit a deflection no greater than 1/180 of span.
[b] Weight, 44 pounds per cubic foot.
[c] Weight, 35 pounds per cubic foot.
[d] Multiply maximum span by creep factor to obtain the span recommended for long-term loading.



Ratios of the shelf spans of plain particleboard and of veneered particleboard to the shelf span of solid walnut. (Fig. 2)

The recommendations permit a deflection of 1/180 of the span, which is the safe deflection for all shelving materials. The famous "5-foot shelf of books," for example, should not bend more than 1/3 inch (1/180 of 60 inches).

As shown in the table, a particleboard shelf 3/4 inch thick and 12 inches wide, loaded with cartons weighing 30 pounds per foot of length, cannot have a longer span than 34 inches. To prevent long-term creep or sag, the span should be shortened to 27 inches (34 x 0.80).

Figure 2 permits a rapid approximation of the ratio of the particleboard and veneered particleboard spans to the span of the walnut shelf. For the same amount of deflection under short-term loading, the span of the veneered particleboard shelf must be 20 percent less than the walnut shelf span; the plain particleboard span must be 30 percent less than the walnut. To prevent creep or sag under sustained loading, the span of the plain particleboard must be reduced by another 10 percent and the span of the veneered particleboard, by 5 percent.

Poo Chow is Assistant Professor of Wood Science, Department of Forestry.

LIQUID DIGESTED SEWAGE SLUDGE Gives Field Crops Necessary Nutrients

O. C. BRAIDS, M. SOBHAN-ARDAKANI, and J. A. E. MOLINA

IRRIGATING CROPS with digested sludge from sewage treatment plants is not a recent practice. But questions as to its value and advisability on a widespread scale are receiving new emphasis as the problem of sewage disposal grows.

Domestic sewers now serve about 125 million people in the United States. Municipal treatment plants are charged with the task of treating the sewage to produce a relatively pure effluent (discharge water). In a few places this effluent must be of drinking quality.

Sludge consists of the nonscreenable solids which have to be removed to purify the effluent. Collection of these solids is the primary step in sludge treatment. If secondary (biological) treatment is included, the sludge is pumped to digesters where biological breakdown of the organic matter occurs anaerobically After several days' detention, the sludge can be disposed of by drying and hauling, incineration, lagooning, or pumping to sea.

The problem of sludge disposal is especially acute in inland cities which cannot dispose of sludge in the ocean. Larger urban populations and higher quality standards for effluents have increased sludge volumes. At the same time lagooning space has become restricted while addition of equipment to control air pollution has increased the cost of drying and incineration. Even where sludge is hauled as far as 17 miles to sea, pollution problems are arising.

Irrigation of cropland with digested sludge is seen as a way of recycling the elements and reducing ultimate disposal costs. Little information has been published, however, about the quantitative effects of sludge on soil and plant nutrition.

To learn more about this subject, a study utilizing an existing lysimeter facility is being conducted on the Agronomy South Farm. (A lysimeter is an enclosed volume of soil which permits the measurement of materials added to or lost from the soil.)

O. C. Braids is Assistant Professor of Soil Organic Chemistry; M. Sobhan-Ardakani, Research Assistant; and J. A. E. Molina, Assistant Professor of Soil Microbiology.

Description of sludge used

Digested sludge is obtained from the Calumet sewage treatment plant of the Metropolitan Sanitary District of Greater Chicago. The components of sludge vary with changes in the influent sewage, so the following figures are to be considered as typical but not definitive.

The sludge is a black slurry usually having a solids content of 2 to 4 percent by weight. About half of the solids are organic materials on a dry weight basis. A 1-inch application of sludge on an acre contains about 330 pounds of nitrogen, 180 pounds of phosphorus, and 40 pounds of potassium. The nitrogen content is too low per unit of wet weight for sludge to compete economically with commercial fertilizers.

Table 1 gives the concentration ranges of some of the elements in sludge. The concentrations of heavy metals (those below magnesium in the table) cause concern that prolonged and heavy applications of sludge could be toxic to plants. However, in the sludges used in our experiment, these metals occur primarily as precipitates, which are not appreciably soluble except at low pH. At sludge pH (neutral or slightly alkaline) or normal soil pH, the precipitates are only slightly soluble.

Table 1. — Composition of Digested Sludge From Calumet Treatment Plant

Component	Concentratio
	ppm
Total nitrogen	1000–3500
Ammonium nitrogen	500–2000
Phosphorus	700–1550
Potassium	150– 175
Magnesium	200– 600
Chromium	10– 50
Cadmium	10– 35
Copper	30– 45
Lead	15– 33
Manganese	4– 15
Nickel	1– 3
Zinc	72– 292
Total solids by weight	1–4 pct

Digested sludge is generally co sidered to be relatively free of path genic organisms. However, sludg undergoing digestion contains fec coliforms (intestinal bacteria), whic are indicators of the possible pre ence of pathogens. After sludge removed from the digester, the fec coliforms die off.

A 99-percent decrease in numbe of fecal coliforms occurred in slud that had been stored 30 days aft digestion. The die-off was even mo rapid in sludge that had been appli to the soil immediately after remov from the digester. Seven days aft application, the coliform count h dropped by 99.9 percent.

The rate of coliform die-off in t soil will vary with soil moisture, p and temperature. As a safety measu sludge is not used on crops that wou be eaten raw by humans.

Crop yields and analyses

Corn, Reed canary grass, and gra sorghums were grown with two lev of sludge irrigation in 1968 and 19 The higher level consisted of inches of sludge in 1968 and 7 inch

Table 2. — Yields of Reed Canary Grass and Sorghum Grain Irrigated With Liquid Digested Sludge

reatment	Reed canary grass 1968	Reed canary grass 1969	Sorghum grain, 1968
	grams, dry weight		
laximum sludge[a]	355.8	345.4	430.4
0 % of maximum[b]	272.6	323.0	284.9
Vater[c]	216.7	187.1	354.8

[a] 10 inches in 1968, 7 inches in 1969.
[b] Water was added to equal maximum sludge eatment in volume.
[c] Same volume as in maximum sludge treatment. 00 lb. N, 100 lb. P, and 100 lb. K per acre were dded in water.

able 3. — Elemental Uptake by Corn rigated With Liquid Digested Sludge

eatment	Manganese, ppm	Iron, ppm	Copper, ppm	Zinc, ppm[a]
	Leaves			
in. sludge	153	215	12	1120
5 in. sludge	45	147	13	1030
in. water	28	181	17	880
	Grain			
n. sludge	3.3	20	2.5	49
5 in. sludge	2.7	16	2.9	53
n. water	2.6	15	3.0	48

[a] Soils were abnormally high in zinc because of the vanized metal used in construction of lysimeter.

1969. This level, without exception, oduced yields as good as, or better an, those obtained with water irrition and relatively high levels of mmercial fertilizer. As an example, e yields for Reed canary grass and rghum grain are given in Table 2. iese crops were grown on 3-foot ameter lysimeters, so yields were not nverted to acre equivalents. It is parent from these results that distted sludge can satisfy the nitrogen d phosphorus requirements of the ops studied.

Nitrogen concentration in plant tiss increased with increasing sludge es, but no harmful effects were ted. The sludge provided several ies the recommended level of rogen.

To assess the influence of heavy tals in the sludge, crops were alyzed for trace elements. In all crops grown, the uptake of manganese, iron, and zinc was generally increased by irrigation with sludge. However, the values were no higher than those reported by Walker and Peck on some unlimed soils in southern Illinois.

Leaf composition changed more than grain composition (Table 3). Therefore, if the leafy growth of sludge-irrigated crops is to be used for feeding, its composition should be checked first. There was evidence that the increased uptake of heavy metals was not simply due to the addition of these metals in sludge. Part of the increase may have been caused by an increased availability of the native supply.

Soil analyses

Soils were periodically analyzed for macro- and micronutrients, pH, and organic carbon. The pH increased from 5.6 to 6.2 in the 0- to 2-inch layer of soils that received 20 inches of sludge (10 inches in both 1967 and 1968). Organic carbon content in this layer increased from 2.1 to 8.7 percent. The added carbon has made the soil surface more friable than that on the control plots. Available phosphorus and potassium also increased with sludge addition.

As expected, heavy metals have accumulated as a result of sludge applications. Cadmium and chromium occur in amended soils, whereas they were previously absent. Concentrations of lead, nickel, manganese, copper, and zinc have increased. However, they have only limited availability to plants because of their

Sorghum growing in lysimeters on University farm. Maximum sludge applications gave better yields than irrigation with water containing relatively high levels of commercial fertilizer.

low solubility at pH 6.0 to 6.5, which is recommended for most Illinois soils.

Drain water

Digested sludge irrigation rates were purposely high, 7 to 10 inches a year, to put stress on the ability of the soil-plant system to utilize added carbon, nitrogen, and phosphorus. Even with these high rates, percolated water from the lysimeters amended with sludge contained about the same level of phosphorus as drain water from control plots. None of the heavy metals specific to digested sludge have been detectable in the percolated water. The water from the sludge-treated plots did contain increased amounts of manganese, magnesium, and calcium, but these elements do not pose a toxicity hazard.

What does constitute a problem is the increased concentration of nitrate-nitrogen found in the water from the sludge-treated plots. Since several times as much nitrogen was added as was required by the crop, some leaching of the excess was expected. Such leaching could prove troublesome if heavy loading rates were used on large areas and excessive amounts of nitrate were carried to ground water or drained to surface waterways. Thus, the nitrogen content of digested sludge appears to be the first limiting factor to loading rate.

Use of lagooned sludge, which contains about half as much nitrogen as freshly digested sludge, would be preferable. Inducing denitrification conditions after irrigation with digested sludge would also reduce the amount of nitrogen prone to leaching.

The Hog Cholera Eradication Program

What are its costs and benefits to hog producers?
How does it affect other special groups?
What are the economic effects on society as a whole?

JOHN T. SCOTT, JR.

HOG CHOLERA is on the rise both in Illinois and in the rest of the country, despite a national hog cholera eradication program. This program was begun in 1962, and by 1965 most of the states had joined it.

Outbreaks reported in the United States reached a low in 1966; the low for Illinois was in 1968 (Table 1). The number of outbreaks appeared fairly constant in 1967 and 1968, but increased sharply in 1969, both in Illinois and in the whole country. This increase has continued into 1970 in Illinois.

Some of the national change in the number of confirmed reports is likely due to better reporting because by 1969 all but 10 states had begun paying indemnities to producers for hogs either exposed to or showing hog cholera. This does not account for the continual decline in Illinois through 1968, however, for Illinois has been paying indemnities for several years.

No outbreaks at all were reported in Illinois during several months in late 1968 and early 1969. Then several outbreaks were reported which were traced to imported feeder pigs. Illinois stopped all vaccination of hogs for cholera on July 1, 1969, and since then outbreaks have been running substantially above previous levels.

Table 1. — Cholera Outbreaks Reported in the United States and Illinois

Year	U.S.	Illinois
1964	1,117	90
1965	881	60
1966	534	46
1967	854	33
1968	822	16
1969	1,481	66
1970	...[a]	25[b]

[a] Data not available.
[b] Data for 1970 are for the first three months.

This level of outbreaks and the resulting indemnities paid have strained the state budget for animal health. It therefore seemed advisable to study the economic costs and benefits of the national hog cholera eradication program.

A phased program

The national program has four phases, to be followed by individual states at their own rate.

Phases I and II are aimed at control. Phase I is a preparatory period, during which regulations and plans for controlling the disease and procedures for reporting and handling outbreaks are initiated. Phase II is the reduction-of-incidence stage, during which modified live-virus vaccine may continue to be used. The reporting of outbreaks is intensified so that the progress in eradication can be better determined. All states in the program have entered or finished Phase II.

Phases III and IV are designated as eradication stages. In these phases all outbreaks are to be eliminated and cholera is to be stamped out. The federal government reimburses state governments for half the indemnity payments made for any cholera-infected or cholera-exposed swine that must be condemned or slaughtered.

During Phase III all infected swine must be disposed of promptly but exposed swine may be salvaged for meat under special inspection. Vaccine m be handled only by authorized pe sonnel.

During Phase IV, no more chole vaccinations of any kind are allowe This phase is a waiting period make sure that hog cholera has fact been eliminated. No choler exposed swine can be sold for slaug ter. All infected and exposed swi must be condemned and disposed immediately. No salvage is permitt

To be declared cholera-free, a sta must go for at least 12 months wi out a cholera outbreak. A state m keep its "cholera-free" designati only so long as no more than an i lated break occurs. An isolated bre is one from which no further co tagion is spread.

Vaccination controlled

According to surveys of the sta cholera vaccination itself was main source of outbreaks in 19 Thus many health committees beli vaccination should be eliminat After this source of infection is moved, they maintain, the remair sources of infection can be stam out fairly quickly. About 56 perc of the cholera outbreaks stem fr neighborhood exposure, shipmen pigs, feeding raw garbage, and known sources.

The federal government has ta steps to discourage cholera vacc tions, with the result that vaccina substantially declined as a sourc infection in 1969. Interstate shipm of modified live-virus vaccine been prohibited since July 1, 1

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Table 2. — Short-Run Costs and Benefits of Cholera Eradication Program to Selected Groups

Group	Costs	Benefits
Hog producers . . .	$ 180,700	$6,000,000
Drug companies . .	2,000,000	. . .
Other businesses		
Direct costs	267,000	. . .
Indirect costs . . .	802,000	. . .
Society as a whole	623,700	2,000,000[a]
Total	$3,873,400	$8,000,000

[a] Assuming that drug companies can shift half their resources to production of other health needs n the first year.

and the interstate shipment of other vaccines is prohibited except to states still in the control phase of the program.

Since January, 1970, the interstate hipment of cholera-vaccinated hogs ias also been banned. However, it s more difficult to control the interstate movement of hogs than the hipment of vaccine.

llinois cholera program

The Illinois program had been rogressing well until the sudden upurn of outbreaks in 1969. Illinois vas in Phase III of the program and vas planning to enter Phase IV, which calls for destroying all exposed vine, as well as all infected animals, ith no salvage. Indemnities are paid n a market price appraisal basis.

Altogether $323,723 in federal and ate indemnities were paid to Illinois roducers in 1969; only a fraction of iis amount was paid in 1968. With ie salvage allowable in Phase III, ie added worth of salvaged hogs in 969 was about equal to the indemnies paid. Thus, at present outbreak vels, Phase IV would have cost alost $700,000 in indemnities paid iring 1969.

One potential source of cholera fection, garbage feeding, has been itlawed in Illinois as of July 1, 1970.

osts and benefits to producers

Without an eradication program, e annual cost of cholera vaccination estimated at $6,000,000 in Illinois. duction of this cost under the eradtion program is a benefit for all g producers (Table 2). This is a short-term benefit which will eventually be passed on to consumers through lower production costs and the free competitive market.

The costs of the program fall on producers whose hogs get cholera or are exposed to it, to the extent that indemnity payments do not cover the loss of income resulting from a cholera outbreak. Also, as taxpayers, producers pay part of the cost of the program.

Loss of income includes not only the indemnity value of the hogs involved, but also feed and clean-up costs, profit foregone on hogs that would have continued to market, and continuing expense while getting back into production. A detailed analysis of these costs is given in my publication, "Hog Cholera Economic Loss and the Multiplier Effect," AE 4227. According to this analysis, producer cost per pig is about $12.50 more than the indemnity paid.

As shown in Table 2, producers' short-run costs of cholera control are estimated at $180,700. This estimate is based on the assumption that eradication costs will remain the same as in 1969. Actually both the number of outbreaks and the indemnity costs were greater during the first three months of 1970 than in the same period of the previous year.

Non-producer groups

In the short run, no special group other than hog producers themselves benefit in any particular way from cholera eradication. Veterinarians and drug manufacturers lose by the amount of reduced vaccination costs on all hogs. However, with the increasing demand for human health products, drug companies can readily shift to production of other needs, so after the initial adjustment, the shift from cholera vaccine benefits society as a whole. Veterinarians can immediately use their valuable services to attack the many other diseases affecting hogs.

Grain dealers in a cholera outbreak area may gain slightly because of grain marketed that would otherwise have been fed to hogs. Other special groups such as feed dealers, machinery dealers, and other businessmen doing business with hog farmers lose according to the level of cholera loss or extent and number of outbreaks. The net direct loss to these nonproducer groups (other than veterinarians and drug manufacturers) is estimated at about $18.50 per hog exposed or infected. This would total about $267,000 a year at the 1969 level of outbreaks (Table 2).

Additional indirect economic effect to business in an outbreak area, due to what is generally known as the "multiplier effect," would be about three times the direct losses or about $55.50 for each exposed or infected hog. Total indirect costs would be about $802,000 (Table 2).

Costs and benefits to society

The costs to society are mainly in the form of taxes to pay for the disease control personnel and the indemnities paid for infected and exposed hogs. Costs of animal disease control have been estimated at about $400,000 in Illinois. Probably about three-fourths of this is allocable to cholera control at this time. The total indemnity in Illinois in 1969 was $323,723, giving an approximate total program cost of $623,700.

Since hog cholera does not generally present a human health hazard as does trichinosis, cholera control does not benefit the public immediately and directly. Most of the benefits will show up in the long run in the form of larger pork supplies and lower pork prices. Society will also receive a short-run benefit and a still greater long-run benefit as drug manufacturers shift from the manufacture of cholera vaccine to the production of other health needs.

Assuming essential eradication of hog cholera, the long-run benefits to society as a whole are estimated at $10,000,000 a year. This includes $6,000,000 of producers' savings passed on in lower pork prices and larger quantity, and $4,000,000 as the result of reallocating drug resources. Against these benefits would be balanced an annual cost of $200,000 for monitoring, control, and indemnities for possible isolated outbreaks.

Family Account Project Is Ended

During 41 years nearly 2,500 families have participated in this project, aimed at promoting economic soundness in the home

MARILYN M. DUNSING and JEANNE L. HAFSTROM

AFTER MORE THAN 40 years, the Illinois Family Account Project is being terminated in 1970. It has been a cooperative effort between Illinois farm and urban families and research and Extension personnel in the Department of Home Economics at the University of Illinois.

Throughout the years the major purpose of this project has been to promote economic soundness in the home, not only for the families who kept account records and sent them to the University for summary and analysis, but for other families as well. With the assistance of county Extension workers, the data from this project have been used to help families develop sound economic principles for managing their financial resources.

M. Attie Souder initiated project

In 1923 Miss M. Attie Souder initiated a program of family account-keeping in Illinois. She was the second home management specialist employed in the University of Illinois Extension Service.

In 1928 Mrs. Ruth Crawford Freeman was hired as an Extension specialist in home accounts in order to direct the program initiated by Miss Souder. That same year the program became a cooperative project of the Extension Service and the Agricultural Experiment Station. The first annual report was published in 1929.

After Mrs. Freeman retired in 1958, Dr. Jean Mann Due acted as project leader until 1962, when Dr. Marilyn M. Dunsing became research project leader. In 1964 Miss Jeanne L. Hafstrom was hired with a joint appointment in Extension and research, with one of her responsibilities being to assist with the research part of the project. Throughout the years hundreds of county Extension advisers have also cooperated in the project in many different ways.

Over 10,000 records summarized

The summary year 1968 marked the forty-first year of the family account-keeping project in Illinois. It also was the final summary year of the project. During the 41 years more than 10,200 records have been summarized.

The number of families participating in any one year has ranged from 88 in 1929 to a high of 492 in 1940. After 1940 the number declined until a low of 115 was reached in 1959.

In 1962 the Illinois Family Account Project was revised extensively, and effort was made to interest more families in participating. Between 1963 and 1964 the number of participating families increased by 81 percent. More than 230 families have participated every year since then. The number of urban families in the project was higher in 1968 (87) than it had ever been except in 1938 and 1939, when urban participation was 105 and 100, respectively.

2,443 families have participated

Records were received from 2,443 different families during the 41-year period. Two families participated all 41 years, and 618 participated five or more years. These 618 families can be grouped as follows according to length of participation:

Years of participation	*Number o[f] families*
35 or more	9
30-35	22
25-30	18
20-25	31
15-20	59
10-15	114
5-10	365

Each year participating famili[es] have sent their Illinois Family A[c]count Books to the Department [of] Home Economics at the University [of] Illinois. These account books co[n]tained complete records of the fam[]ilies' annual income and expenditure[s]. A detailed summary and analysis [of] all the data have been published eve[ry] year. In recent years, the data ha[ve] been summarized and analyzed n[ot] only for all farm families but also f[or] all urban families as a group. In add[i]tion, each of these groups has be[en] divided into subgroups based on si[ze] of income, number in the family, a[nd] stage in the family life cycle.

Detailed information has also be[en] presented on the total and per-pers[on] value of food consumed, clothing e[x]penditures, and life and health insu[r]ance coverage; and on total fam[ily] indebtedness. Figures are given f[or] all families and for the subgrou[ps] mentioned above. In addition, fa[m]ily living expenditures for the year f[or] the report have been compared w[ith] expenditures during the precedi[ng] 20 years. In these comparisons bo[th] total expenditures and expenditu[res] for the major categories of family l[iv]ing have been considered.

Marilyn M. Dunsing is Professor and Jeanne L. Hafstrom is Instructor, both in Family Economics, Department of Home Economics.

In earlier years of the project, per-
›nal visits were made to the families
› help them interpret their income
ıd expenditures. In recent years,
ttensive correspondence has taken
ıe place of personal visits. Fre-
ıently, after a year or two of detailed
ılp families have sent in balanced
:count books on the first attempt.
nce 1962, a family's account records
ıve not been included in the state
mmary if the balancing error ex-
eded $100. This constraint has en-
ıuraged families to work harder to
count for money income and outgo
ıd has also helped some families
ve money on their taxes.

In recent years participating fam-
es have been sent every annual re-
ırt. Each family has also received
summary balance sheet of its in-
ıme and expenditures, plus a sum-
ıry and percentage breakdown of
lividual family living expenditures
use in comparing its own expen-
ıures with those of other families in
e project.

The annual report from this proj-
has been widely used by Extension
ecialists and advisers both in home
onomics and in agriculture. Resi-
nt and Extension personnel at other
te universities have also made use
the report. The Food and Con-
ner Utilization personnel at the
S. Department of Agriculture used
ne of the data in one of the farm
lexes they construct.

The project has made a significant
ıtribution to the research training
graduate students in family and
ısumption economics. It has pro-
ed experience in making many of
concepts in this area viable, as
l as experience in summarizing
l analyzing the data.

ated projects

or the past five years the family
ount data from farm families have
n summarized and analyzed on a
nthly as well as a yearly basis for
major categories of family living
enditures. These findings will be
mitted for publication during the
ing year.

lans are being made to request
ds to put the farm family data for

Mrs. Ralph Abbadusky of Fulton County, with her husband, participated in the Family Account Project during every one of the 41 years that the project was active.

Another 41-year account-keeping family are the Eldon D. Gileses of McDonough County. Mrs. Giles is shown with her daughter, Mrs. Eldon A. Ruebush. Following the family tradition, Mrs. Ruebush has kept accounts for 18 years.

the 41-year period on IBM cards so that a time analysis of income and expenditures may be undertaken using various definitions of income. Income elasticities will be obtained for major categories of living expenditures.

Another project grew out of the income-expenditure study reported above. This project is a longitudinal study to obtain insights concerning the effect of aging upon the income and expenditures of Illinois farm families. Data are available for two dozen families during the major part of their life cycle. Illinois appears to be the only state in the country that has such data for a period of 20 to 30 years. The expenditure data have been summarized on both a current and a constant dollar basis.

The data are currently being analyzed to determine the relationship between the participating families' 20- to 30-year income (using different definitions) and their total family living expenditures. Each of the farm families has been interviewed to obtain more information about the family's financial management practices during the 20- to 30-year period.

Help will continue

Although the Illinois Family Account Project ends this year, farm and urban families throughout Illinois will still be able to get help with family accounts and record-keeping. Through the Cooperative Extension Service, families in a county can request help in keeping and using account records and thus increasing the family's satisfaction per dollar spent.

The Illinois Family Account Book will continue to be available at a nominal charge from the county Extension adviser's office or from the Agricultural Publications Office, 123 Mumford Hall, Urbana, Illinois 61801.

Microwave Energy Keeps Potato Chips From Overbrowning

VERNON L. PORTER

A MAJOR PROBLEM in the manufacture of potato chips is maintaining an acceptable color. If the chips get too brown, most consumers don't want them.

Browning of potato chips (called Maillard browning) results when reducing sugars react with amino acids and related compounds at high temperatures. So the greater the amount of reducing sugars, the greater the danger of overbrowning. The reducing sugar content of potato tubers depends on many factors such as variety, maturity, cultural practices, and length and temperature of storage.

Potato chip manufacturers have tried various techniques for controlling browning. The most common method is to control the temperatures at which raw tubers are stored. The lower the temperature, below 55° F., the greater the development of reducing sugars. Above 70° F., the reducing sugars will revert to starch.

Because of spoilage and shrinkage at reconditioning temperatures, storage can become expensive and difficult for potatoes that are intended for chipping. The problem is increased if good chipping varieties are in short supply, weather conditions are unseasonable, or storage is inadequate.

Several methods of treating raw potatoes have been developed to slow up the development of reducing sugars during storage, but these treatments are all expensive.

Recently the use of microwave energy has been promoted as an answer to some of the color problems in potato chip manufacturing. Chips are pre-fried in oil and then finished with the microwave energy. This way the chips can be finished without being heated to the Maillard browning point. As a result, higher levels of reducing sugars are acceptable in the potatoes. According to some reports, the cost of the microwave energy is offset by the savings experienced when potatoes can be stored at lower temperatures.

Because of the interest in microwave drying of potato chips, a study was conducted of its effects on texture and the acceptable levels of reducing sugars.

Texture

One series of tests was set up to answer this question: How is the texture of microwave-finished chips affected by the moisture content at which the pre-fried chips are removed from the oil? To eliminate other variables as much as possible, some chips from every lot in every test were conventionally finished as controls — that is, they were fried to about 2 percent moisture content.

The first task was to establish time and temperature information for pre-frying the chips to a specific moisture content. Several small batches of sliced potato tubers with low reducing sugar contents were fried in oil at 160° C. for varying lengths of time.

Table 1. — Shear Press Readings of Chips Fried to Different Moisture Levels Before Microwave Finishing

Moisture percent after frying	Mean shear press readings[a]
2.20 (control)	30
3.68	31
4.40	31
6.12	32
8.04	33
8.75	33
9.80	34
13.44	39
13.90	39
16.10	41
16.51	42
17.50	45
19.37	46
21.06	46
23.75	47
26.10	54
32.30	59

[a] Averages rounded to whole numbers. A reading of 26 to 32 is excellent.

Lots were sampled for moistu before and after drying. Texture the finished chips was measured on shear press, which records the pow needed to force a series of prongs in a sample. (During the experiment, producible objective texture tests we developed with this press.) Results f the initial texture tests (Table were valuable in establishing moistu levels for further experiments.

A panel of judges was asked evaluate the finished chips by tou and taste. On the basis of their ev uations it was determined that a sh press reading under 40 would p duce an acceptable texture for e average consumer. The lower e shear press reading, the more ten the potato chip.

Further experiments were co ducted with four batches that we pre-fried to 6.92, 12.68, 18.6, ad 21.92 percent moisture levels. Af

Table 2. — Texture Ratings for Ch Fried to Different Moisture Level Before Microwave Finishing

Moisture percent after frying	Mean shear press readings[a]	Aver. judge rating
2.60 (control)	30.9	8.9
6.92	32.4	8.0
12.68	39.3	7.1
18.63	43.6	5.0
21.92	47.3	4.9

[a] A score of 26 to 32 is excellent; under 40 ac ceptable.
[b] A score of 9 is perfect; 5, unacceptable.

Table 3. — Oil Contents of Mi wave-Finished Chips and Convent ally Fried Chips From the Same and With the Same Range of F Moisture Contents

Replication no.	Oil content, perc: Microwave-finished	Conventionally fri
1	33.92	39.3
2	32.38	33.5
3	38.47	43.7
4	33.00	36.3
5	37.84	39.3
6	38.23	44.8
7	31.80	34.0
8	34.95	38.5
9	38.92	45.7
Average	35.50	39.6

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nicrowave finishing to moisture con-
ent of about 2.4 percent, the chips
were evaluated for texture both on
he shear press and by a panel of
even judges.

As shown in Table 2, the shear
ress readings were very acceptable
oth for the control lot and for the
ot that had been pre-fried to 6.92
ercent moisture before microwave
nishing. The evaluation of the
idges confirmed this finding.

The lot that was pre-fried to 12.68
ercent was less desirable, according
o both the shear-press readings and
ne panel, but it was still acceptable.
gain the two evaluating methods
ere in good agreement. Samples
re-fried to 18.63 and 21.92 percent
oisture before microwave finishing
ere unacceptable by both methods
f rating.

From these results it was concluded
nat the moisture content of pre-fried
nips can be as high as 12 to 13 per-
ent without seriously impairing the
xture of the finished chip.

educing sugars

Once the maximum moisture level
pre-fried chips was established,
was necessary to determine the
aximum level of reducing sugars
at could be tolerated. This study
as made with Russet Burbank pota-
es having five levels of reducing
gars: 0.45, 0.65, 0.75, 0.90, 1.05,
d 1.99 percent.

Slices were pre-fried at 160° C.
itil the color was acceptable for
tato chips. The pre-fried chips
ere then finish-dried with micro-
ave to about 2.2 percent moisture.
control lot at each reducing sugar
vel was finished in the oil.

Every control lot was too brown
r consumer acceptance, but every
crowave-finished sample had excel-
nt color. However, lots that had
ore than 0.9 percent reducing sugars
d not have acceptable texture. To
event overbrowning, these lots had
be removed from the oil at too
h moisture contents.

It was concluded from these exper-
ents that potatoes with reducing
gars as high as 0.9 percent could
processed into potato chips with
acceptable color and texture. Many factors, however, might raise or lower the maximum level of reducing sugars that would be acceptable. Each processor will have to evaluate the effects of storage conditions, variety, and processing variations.

Oil content

Oil content of the controls and the microwave-finished chips was monitored throughout the experiments. Microwave-finished chips were found to have 10 to 20 percent less oil content than the conventionally fried controls from the same lot (Table 3). The variations can be attributed to different varieties and different processing techniques. Texture of the microwave-finished chips was not appreciably affected by the reduced oil content.

High Post-Harvest Temperatures Retard Sprouting of Fall-Planted Onion Sets

H. J. HOPEN, R. R. DEDOLPH, W. F. WHITESIDE, and W. CHORNEY

ONION (*Allium cepa*) sets grown in northeastern Illinois are usually harvested during late summer or early fall and stored over winter for spring planting. Sprouting at that time is early and uniform.

In recent years some freshly dug Illinois-grown sets have been shipped south and planted immediately to produce green onions for the fall market. These sets, without overwinter storage, occasionally failed to sprout or sprouted erratically.

Clearly the problem is one of an induced rest period. For when the onions are planted in the south, environmental conditions are adequate for early and uniform sprouting. To determine the cause and possible solutions of the problem, a cooperative study was undertaken by the Department of Horticulture and the Argonne National Laboratory.

Many treatments are known to act alone or together in modifying the length of rest period in plant tissues. Among these can be ionizing irradiation, temperature, and humidity during post-harvest storage.

During this four-year study, storage temperature immediately after harvest had the greatest effect on the rest period of freshly dug onion sets. Onset of growth was greatly delayed in sets stored at 113° F. for more than 24 hours, though not in sets stored at this temperature for 24 hours or less. Sets stored at temperatures of 41° F. for 1 to 10 days did not go into a rest period.

Low humidity during storage delayed growth slightly, but only when the storage temperature was 113° for more than 24 hours — a condition that in itself delayed growth.

Gamma radiation from a Cobalt 60 source had little effect on set growth when doses were less than 800 rad (a rad is a measure of ionizing irradiation). With doses of 1,600 to 12,800 rad, growth was delayed, the delay increasing with the amount of dosage. Irradiation effects became more pronounced at a storage temperature of 113° F.

Year-to-year variations in results from the low-temperature treatments, which caused the earliest and most uniform sprouting, showed that field disposition did affect the time of sprouting, but usually very little.

The finding that high storage temperatures delay sprouting sheds light on some basic questions concerning rest period. The finding also has economic value, leading to the recommendation that freshly dug sets be shipped south in refrigerated trucks. If this is done, Illinois-grown sets should consistently produce profitable green onion crops in the fall.

H. J. Hopen and W. F. Whiteside are on the University of Illinois staff; R. R. Dedolph and W. Chorney are with the Argonne National Laboratory. This work was performed in part under the auspices of the U.S. Atomic Energy Commission.

Uttar Pradesh Agricultural University, Sister Institution of the U. of I. in India

A. E. THOMPSON

A NEW university is flourishing in India, on land that was a swampy, uninhabited jungle 25 years ago. The university is the Uttar Pradesh Agricultural University (UPAU), which was established by the state legislature of Uttar Pradesh in 1958 and admitted its first students in 1960. The former jungle is the Tarai, a 20-mile wide alluvial plain running some 150 miles along the base of the Himalayan foothills.

Before World War II, malaria-bearing mosquitoes prevented settlement of the Tarai. After the war, the mosquitoes were largely eliminated by DDT and the land was cleared and drained. Much of the land was settled by refugees resulting from the partition with Pakistan. The 16,000-acre Tarai State Farm was established in 1948 as part of the colonization scheme. This farm was chosen as the site of the new campus, and 14,255 acres were transferred to the university.

The Tarai has a tremendous potential for agricultural production, being blessed with good soils, readily available irrigation water, and a favorable climate. Sugar cane can be grown throughout the year; corn, sorghums, rice, and soybeans during the kharif or monsoon season from mid-June into October; wheat, mustard, peas and other pulse crops, sugar beets, potatoes and other vegetables during the winter or rabi season. Short-duration crops of the pulses, corn, and perhaps even soybeans can be grown during the hot dry months of March to June. Rotations are being developed to produce three or even four crops a year on the same acreage.

UPAU's success

UPAU is rapidly becoming a major asset to India. Much of its success can be attributed to Vice Chancellor D. P. Singh, who took charge in 1966, and to a highly competent staff. Also the University of Illinois can take pride in its contributions, which began even before the "blueprint" stage.

Patterned after the U.S. Land-Grant university, UPAU represents a complete break from the traditional system of education that borrowed heavily from the British pattern. It was the first agricultural university in India and is the only one to have started as a completely new institution without any pre-existing colleges or other academic units.

The University now consists of three colleges and one school. The College of Agriculture, the College of Veterinary Medicine, and the School of Basic Sciences and Humanities were started in 1960. The College of Agricultural Engineering was started in 1962 and was converted to a full-fledged College of Technology in 1966, offering degrees in several kinds of engineering. A College of Home Science is expected to be established this year.

UPAU now has over 250 academic staff members and a student enrolment of more than 1,600. Through 1969, it conferred 1,231 B.S. degrees and 239 advanced degrees.

Student programs

Among the many innovations that UPAU has introduced to India are several types of student work programs. One is a compulsory program for first-year students. It includes such jobs as detasseling corn, transplanting rice, weeding, hoeing, and caring for college buildings and grounds.

In addition, a voluntary program of "earn while you learn" enables students to earn part of their expenses

UPAU students earn while they le[arn] These young men are making whe[at] crosses at the Crops Research Ce[nter]. The Administration Building and pa[rt of] the Auditorium are shown in the b[ack]ground.

while doing an essential job — wo[rk]ing in the library or an office, for ex[ample], or as part-time labora[tory] assistants.

During his final year a stu[dent] must pass the Practical Crop Pro[duc]tion course in order to receive [his] B.S. degree. Teams of eight stu[dents] are formed and each team is giv[en a] 5-acre plot to manage as a comme[r]cial enterprise. Students may de[cide] their own cropping pattern and pra[c]tices, but must do all their own [wor]

A. E. Thompson, Professor of Plant Ge[neti]cs, Department of Horticulture, was Chief o[f Pa]... at UPAU from 1967 to 1969.

ıny profit or loss made by a team is hared by all the members. Most eams realize a good profit.

Under a new apprentice program, limited number of graduates may ach use 10 acres on the University ırm for one year. Backed by a loan om the State Bank of India, each raduate buys or rents the necessary ed, equipment, and other inputs om the University. He retains any et profit he can make, thus acquirg a good "nest egg" as well as exrience.

The University has an excellent udent advisory system. It also has placement service to help students t good jobs upon graduation.

aff duties

Academic staff members usually ork in two of the three areas of aching, research, and extension. But en if a staff member does not have extension appointment, he is ually expected to do some work th the farmers and agribusiness.

The State Extension Service in tar Pradesh is under the State Dertment of Agriculture. Although it ludes regulatory and distributive well as educational functions, exsion activities at UPAU are coned to education. The University rks directly with farmers in the rai and now has extension assists in over one-third of the districts oughout the state.

The agricultural research program f Uttar Pradesh is also under the te Department of Agriculture, and date no state-wide responsibility for earch has been given to UPAU. e University has, however, develd a strong research program, with phasis on practical projects.

At the 500-acre Crops Research ter, excellent research is being ducted on production of field and etable crops, plant breeding, soil d plant nutrition, and control of ases, insects, and weeds. Research livestock, chiefly dairy cattle, bufes, and poultry, is conducted on Livestock Research Center, conng of over 500 acres. A new ticultural Research Center is bedeveloped on a 250-acre tract on the University Farm. Main emphasis at this site will be on fruits.

Contributions of the U. of I.

The University of Illinois has worked with UPAU under two separate but fully integrated programs. The major program has been funded by USAID and has been concerned with all aspects of institutional development at UPAU. The second program, supported by the Ford Foundation, is aimed at developing the Department of Agricultural Economics. Altogether 44 U.S. specialists have worked 633 man months under AID contracts. Eight have worked 55 man months under Ford contracts.

Originally the Illinois staff member at UPAU served chiefly as an adviser and generalist, articulating the educational concepts of the U.S. Land-Grant institutions. Our team members contributed greatly in such areas as curricula development, internal examinations, improved teaching methods, visual aids, selection and upgrading of academic and nonacademic staff, improving hostel facilities and food services, and developing student advisory services.

Now many of these ideas are well planted and are being utilized. Although we are still concerned with them, American staff members are more likely to serve as visiting professors, helping to strengthen a specific subject-matter area.

One of the most significant contributions we have made to UPAU has been the improvement of academic staff through the Illinois/USAID Participant Training Program. Forty UPAU staff members have received or are now receiving advanced training at the University of Illinois or some other U.S. institution under our guidance. Two other staff members are currently working on their Ph.D. at Urbana under our Ford Foundation contract. In the future we hope to have more exchanges of both professors and students between UPAU and the University of Illinois, to the enrichment of both institutions.

Another contribution has been the development of demonstrational and teaching aid projects with the support of contract rupee funds. These projects are developed jointly by the Illinois team member and his Indian counterpart. During the past two years laboratories in soil, land, and water development have been upgraded; a radio-tracer laboratory, an asceptic orthopedic surgery laboratory in veterinary medicine, and a cold-storage facility for storing plant breeders' seed have been built; various teaching aids have been developed; and two Returned Participant Seminars, as well as the first All India Agricultural Marketing Conference, have been sponsored.

Contract rupee funds, as well as other funds, have also supported the Soybean Coordinated Research Project (ILLINOIS RESEARCH, 11:4). This is a good example of the collaborative research between the University of Illinois and UPAU. Not only has this program benefited India directly, but it has served as a model for organizing other cooperative research programs in India. It also has implications for improving soybean culture in the United States.

Many other examples could be cited of cooperative research which will benefit both countries. As just one example, exotic insects and plant diseases which may eventually threaten our crops are being identified and studied. We certainly will enrich the educational programs of our students by incorporating into our courses the new ideas acquired through contact with other cultures and agricultural systems.

The people of Illinois have been supporting this worthwhile program, but only in an indirect way, since most of the funding has been with federal money. Increase in state support of international agricultural programs can be supported not just in humanitarian terms but also in terms of enlightened self-interest. Helping people in other countries to develop a dynamic economy will expand the opportunities for exporting products from the technically advanced nations. Investment in international agricultural development is an investment in Illinois's economic future.

Nutrient Levels of Corn and Soybean Fields Remain High

A three-year study covering 75 counties indicates that most Illinois soils have adequate nutrients for high crop yields

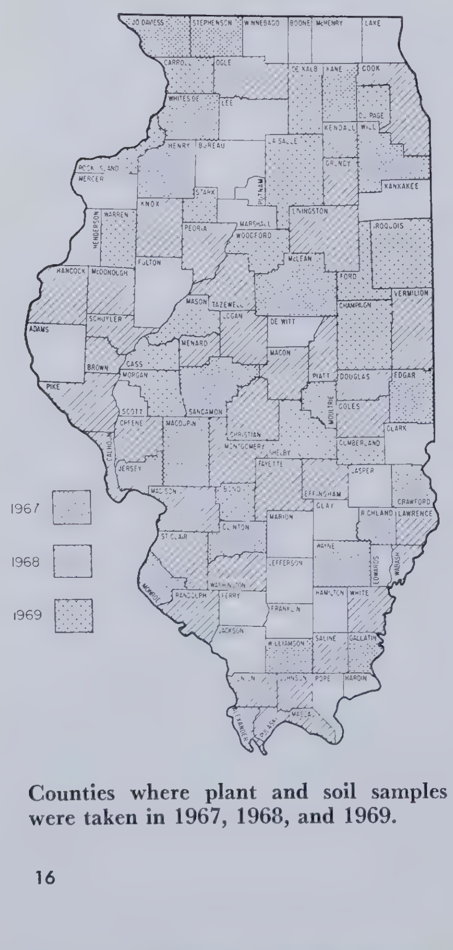
W. M. WALKER, T. R. PECK, S. R. ALDRICH, and W. R. OSCHWALD

A THREE-YEAR study of the nutrient levels in Illinois corn and soybean fields was concluded in 1969. Sixteen counties were surveyed in the last year, making a total of 75 for the three years (see map).

The same basic plan was followed in 1969 as in the previous years. Soil samples were obtained at each site from three depths: 0-6 inches, 12-18 inches, and 24-30 inches. Each sample was analyzed for available phosphorus (P_1), exchangeable potassium, and soil acidity (pH).

Corn and soybean plants were sampled early in the growing season and at midseason. Early-season samples were taken when corn plants were 12 to 18 inches and soybeans were 5 to 10 inches in height. Samples at this stage consisted of whole plants. Midseason samples were taken from corn at the early tassel stage and from soybeans when they had reached full height. The leaf opposite the ear was taken from corn plants, and the topmost fully developed leaf from soybean plants. Samples were analyzed for nitrogen, phosphorus, potassium, calcium, magnesium, boron, copper, iron, manganese, zinc, and sodium.

Mean levels of various elements in corn and soybeans for the two sample periods in 1969 are presented in Table 1. Average values for most elements in both sample periods did not greatly differ from those obser in other years (ILLINOIS RESEAR 10:3 and 11:2). Potassium le were somewhat higher in both cr in 1969, but would not be conside excessive.



Counties where plant and soil samples were taken in 1967, 1968, and 1969.

Table 1. — Mean Levels of Various Chemical Elements in Corn and Soybean Plants, 1969

Chemical element	Corn Early	Corn Mid-season	Soybeans Early	Soybeans Mid-season
N, pct.	3.76	3.28	4.53	5.02
P, pct.	0.35	0.30	0.31	0.33
K, pct.	3.53	2.26	2.22	2.07
Ca, pct.	0.46	0.58	1.37	0.98
Mg, pct.	0.32	0.31	0.58	0.45
B, ppm.	16	10	43	46
Cu, ppm.	12	12	14	14
Fe, ppm.	367	147	450	134
Mn, ppm.	67	59	86	69
Zn, ppm.	41	34	54	52
Na, ppm.	218	174	326	235

Table 2. — Mean Soil Test Values in Corn and Soybean Fields, 1969

Soil depth, inches	Corn pH	Corn P_1	Corn K	Soybeans pH	Soybeans P_1	Soybeans K
		lb./A.			lb./A.	
0-6	6.4	77	393	6.3	53	307
12-18	6.1	22	288	6.1	19	253
24-30	6.2	23	303	6.4	18	279

Most calibrations of leaf nutr levels with subsequent yields indi that, on the average, the nutri status of sampled fields in 1969 a adequate for high corn and soyb yields. Estimated average yields i Illinois were relatively high in 196 98 bushels per acre for corn and bushels for soybeans. Judging fr the average nutrient values in Tab 1, some factor other than these nu ents probably kept yields from b even higher.

Mean soil test values in corn a soybean fields, shown in Table 2, consistent with the plant chem composition given in Table 1 support the conclusion that the nu ent environment for corn and beans was, on the average, adeq for high yields in 1969. The dat Table 2 are similar to those repo in previous years.

Even though the average soil values may be adequate for crop duction, the distribution of sam at different soil test levels ma more informative. The distribu of soil test values in the top 6 in of soil is given in Table 3.

According to Table 3, 94 samp from corn fields and 76 samples soybean fields were moderatel severely acid, indicating a nee agricultural limestone. About 21 cent of the corn fields and 36 pe of the soybean fields needed mod to large applications of phosph if crop needs were to be met. Al half (48 percent) of the corn f and more than half (59 percent

ybeans at the early sampling stage.

e soybean fields needed moderate large amounts of potassium.

Some corn and soybean fields were ry high in soil phosphorus and po- sium. The highest values in Table ire considerably above crop require- nts. It is possible that soil samples m some fields contained unreacted tilizer particles from prior fer- zer applications. However, some ues at the 12- to 18-inch and 24- 30-inch depths were also very high. is unlikely that unreacted fertilizer ticles were this deep in the soil file.

Some correlation coefficients be- en plant and soil nutrients and ween nutrients within the plants presented in Table 4. Correlation fficients measure the linear associ- n between two variables. For ex- ple, when we apply fertilizer we erally expect an increase in crop d, or a positive correlation be- en yield and fertilizer.

ome of the significant correlations Table 4 were to be expected. One the negative correlation between assium and magnesium in both n and soybean leaves. According past laboratory and field exper- nts, there is a negative association

Table 3. — Frequency Distribution of Surface (0"-6") Soil Test Values From Corn and Soybean Fields, 1969

pH range	No. of samples: Corn	No. of samples: Soybeans	P_1 test range, lb./A.	No. of samples: Corn	No. of samples: Soybeans	K test range, lb./A.	No. of samples: Corn	No. of samples: Soybeans
<4.5	0	0	0–5	2	1	<90	2	0
4.6–5.0	4	4	6–10	5	4	91–120	7	9
5.1–5.5	30	17	11–20	20	19	121–150	7	15
5.6–6.0	60	55	21–30	36	48	151–180	18	11
6.1–6.5	89	51	31–40	38	37	181–210	20	8
6.6–7.0	74	41	41–50	34	19	211–240	27	19
7.1–7.5	37	21	51–60	29	11	241–270	36	29
7.6–8.0	12	10	61–70	22	9	271–300	29	26
>8.0	0	0	71–80	15	10	301–400	83	46
			81–100	28	20	401–500	25	11
			101–200	60	16	501–800	31	18
			201–300	8	4	801–1100	11	5
			>300	9	1	>1100	10	2
Highest observation	8.0	8.0	...	492	360	...	4708	1450
Lowest observation	4.8	4.9	...	3	3	...	74	92

Table 4. — Simple Correlations Between Plant and Surface-Soil Nutrients and Between Nutrients in the Plant, Corn and Soybeans, 1969

Factors correlated	Corn correlations: Early	Corn correlations: Midseason	Soybean correlations: Early	Soybean correlations: Midseason
ppm B with soil pH	−.098	−.035	−.004	−.074
ppm Mn with soil pH	−.342**	−.388**	−.014	−.166*
ppm Zn with soil pH	−.248**	−.134*	−.230**	−.251**
Pct. Mg with soil pH	.069	.122	.171*	−.014
Pct. Ca with soil pH	.044	.213**	.295**	.057
Pct. P with soil P	.304**	.227**	.194*	.164*
ppm Zn with soil P	.102	.089	.113	.142
Pct. K with soil K	.308**	.357**	.455**	.375**
Pct. Mg with soil K	−.236**	−.277**	−.316**	−.231**
ppm Mn with soil K	−.157*	−.177**	−.235**	−.100
ppm B with soil K	−.027	−.027	−.090	−.161*
ppm Na with pct. K	.136*	.256**	.120	.167*
Pct. Mg with pct. K	−.478**	−.578**	−.362**	−.327**
ppm Mn with pct. K	−.182**	−.045	−.226**	−.249**
ppm Mn with pct. Mg	.225**	.118	.408**	.486**
Pct. Mg with pct. N	.138*	.232**	.155*	−.155*
ppm Zn with pct. P	.303**	.351**	.344**	.336**

* Odds are 19 to 1 against a chance correlation this large.
** Odds are 99 to 1 against a chance correlation this large.

between these two elements in terms of uptake by the plant. The numerical value of the correlation, however, will vary with different samples or crops.

Generally, the solubility of soil manganese and zinc decreases with an increase in soil pH. Thus, the negative correlation between soil pH and leaf manganese and zinc was expected.

Soil phosphorus was positively correlated with leaf phosphorus, and soil potassium was positively correlated with leaf potassium in both crops. This confirms previous findings that soil test levels of these elements are, to some extent, a measure of their availability to the crop.

Although the soil survey has been concluded, further analyses will be made of the data. We will, among other things, pool the data by soil areas to determine whether we can be more precise in suggesting fertilizer rates based on soil tests.

W. M. Walker is Associate Professor of Biometry and Soil Fertility; T. R. Peck, Associate Professor of Soil Chemistry; S. R. Aldrich, Professor of Soil Fertility Extension; and W. R. Oschwald, Associate Professor of Soil Classification, all in the Department of Agronomy.

RESEARCH IN BRIEF

Level of Amino Acids in Ruminant Diets Has Major Influence on Performance

What is the first performance-limiting factor of growing ruminants? The level and pattern of essential amino acids reaching the absorption sites, according to recent research in the Animal Science Department.

For years the level of dietary protein has been generally accepted as the principal criterion for determining the protein adequacy of ruminant diets. The consensus has also been that the ruminant has no need for dietary amino acids.

These opinions are probably right if one is willing to accept the kind of performance that has been obtained with growing ruminants the past few decades. Nearly all improvements in the performance of growing ruminants can be attributed to refinement of management (such as continuous feeding of completely mixed feeds) or better control of the environment (including improved sanitation and disease control). Responses to new dietary adjustments have been minor except, perhaps, for responses to diethylstilbestrol in finishing lambs and cattle.

Now, however, we have conclusive data to show that the levels and patterns of amino acids at the absorption sites influence performance significantly. These data were obtained by administering various mixtures of amino acids through a tube into the abomasum. This prevented rumen microbial destruction or alteration of the amino acids.

To find a practical application of this basic finding, we have been working with chemicals that will protect dietary amino acids from destruction and alteration by microorganisms in the rumen. Several compounds have proved satisfactory in laboratory tests.

In the feedlot, too, four compounds (tannic acid, formaldehyde, glyoxal, and glutaraldehyde) have given satisfactory preliminary results. Soybean meal that has been treated with these compounds has been fed to cattle and lambs as the supplementary protein source. Nitrogen balances have been improved in lambs receiving the treated meal. Both lambs and cattle on the treated meal have gained faster and used feed more efficiently than animals on untreated meal. Following is the performance of five lots of steers (15 in each lot) fed treated or untreated soybean meal for 112 days:

Treatment	*Av. daily gain, lb.*	*Gain: feed ratio*
Untreated meal . . .	2.97	.183
Tannic acid	3.05	.198
Formaldehyde	3.17	.188
Glyoxal	3.32	.194
Glutaraldehyde. . . .	3.19	.193

These results should be encouraging to the soybean producer as well as to the livestock feeder. — *E. E. Hatfield, G. T. Schelling, Ken Nimrick, A. Driedger, A. P. Peter, and Arnold Peterson*

Ruminants Can Utilize Large Amounts of Urea

Protein, already a very costly item in ruminant rations, is expected to become even more expensive with the present trend toward using soybean protein for human needs.

Cattle and sheep do not need to compete with man and other nonruminants for high-quality proteins, however, since ruminants have the unique ability to convert nonprotein nitrogen into protein. Urea is the most commonly used and cheapest source of nonprotein nitrogen.

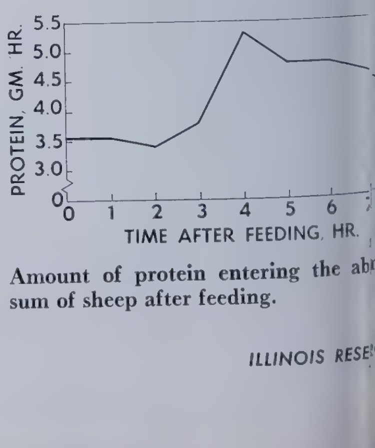
Urea is rapidly hydrolyzed in the rumen and the resulting ammonia may prove toxic when the urea is fed at high levels. We are therefore conducting research to determine the optimal conditions for urea use by ruminants fed a high-energy finishing diet.

Four sheep were equipped with permanent infusion tubes into the rumen for administering the urea, ar tubes into the "true stomach" abomasum for sampling material aft it left the rumen. A basal diet 72 percent corn grain, 12 perce cellulose, 10 percent alfalfa meal, ar 5 percent molasses, plus needed vit mins and minerals, was fed twi daily. Urea was infused into the r men to increase the protein le from the 8 percent basal to 12, or 20 percent crude protein equiv lent.

The urea infusions did not fluence food intake and energy gestibility. In contrast, animals rations that contain urea commo cut down their feed consumpti especially during the first few days a diet that is high in urea. Apparen this reaction is due to taste or ot factors not associated with metaboli of the urea. When urea is fed, it n be desirable to mask the flavor w molasses or similar materials.

The continuous infusion of high level of urea provided over grams of urea per sheep per da more than twice the amount tha normally considered lethal. Yet animals remained alert and act Evidently urea toxicity is due t large dosage in a short time. He urea in the ration should be dilu to provide a continuous intake rat than a large single dose.

As shown on the chart, it t some time for most of the protein reach the abomasum when anim are fed the basal diet. This dela probably due to a lag in bact synthesis. The curve also indic



Amount of protein entering the ab sum of sheep after feeding.

at the supply of amino acids to the minant animal, although continuis, is variable. The basal diet, however, has less crude protein than ould be recommended for growing mbs. According to preliminary observations, the supply of protein in the omasum would be less variable th added urea than with the basal et alone. The protein supply would so be more constant with more equent feeding of animals.

In conclusion, these experiments ovide evidence that diets with a gh urea content are most efficiently ed if the diet is adequately mixed d if it is fed frequently or free oice. — *W. M. Knight, F. N. vens, and U. S. Garrigus*

gh-Quality Corn Results om Low-Temperature ying With Electric Heat

periments with corn harvested in 59 showed that corn can be dried isfactorily with electric heat at low nperatures, provided the airflow is east 1 cfm per bushel.

The tests were conducted in three 00-bushel bins on a University-ned farm near Monticello. Within or two days of November 25, the s were loaded with shelled corn ing a moisture content of 18.5 to percent.

Bin 1 was equipped with a 3-horsever fan that supplied an airflow about 1 cfm per bushel. A 10-watt electric resistance heater was alled in the transition section lead- to the plenum under the perfod floor. The heat from two stages he heater (6.6 kilowatts), together the motor heat, raised the dry- temperature about 8 degrees.

in 2 was equipped with a 1-horseer fan that delivered an airflow nly ½ cfm per bushel. Air temture was raised 5 degrees by two es (3.3 kilowatts) of a 5-kilowatt tric heater and by the heat of the motor.

in 3 was also equipped with a rsepower fan delivering an air- of ½ cfm per bushel. No heater installed in bin 3. The fan motor raised the air temperature about 2 degrees.

Moisture Content of Shelled Corn Dried Under Three Conditions

Corn level, ft.	Bin 1	Bin 2	Bin 3
	pct. moisture content		
15	15.0	...	18.6
14	15.0	18.2	18.4
13	14.8	18.2	18.6
12	14.8	17.8	18.6
11	14.7	17.2	18.4
10	14.8	17.2	18.0
9	14.7	16.8	18.2
8	14.8	16.4	18.2
7	14.5	16.2	18.4
6	14.5	15.8	18.4
5	14.7	15.4	18.2
4	14.5	15.2	17.6
3	13.9	15.0	18.0
2	14.1	15.0	17.6
1	14.4	14.4	17.0
Floor	13.9	13.7	16.6
Aver.	14.6	16.2	18.1
Days of operation	28	73	73
Total kwh	6450	7530	1750
Kwh/bu.	2.05	2.40	0.57
Kwh/bu. per % point of moisture removed	0.5	1.0	1.0

The corn in bin 1 dried to an average moisture content of 14.6 percent in less than a month (see table). The moisture content ranged from 13.9 percent at the perforated floor to only 15 percent at the 15-foot level. The 8-degree increase in heat was small enough to maintain relative humidity at 55 to 70 percent and thus prevent overdrying.

In bins 2 and 3, an airflow of only ½ cfm did not dry the corn before the onset of cold weather. When the average daily temperature begins to drop below 30° F., drying becomes extremely slow and energy is used less efficiently. The energy requirement in bins 2 and 3 was 1.0 kilowatt hour per bushel for each percentage point of moisture removed; only 0.5 kilowatt hour was required in bin 1.

In bin 3, where the fan motor supplied the only heat, moisture content did not go below 16.6 percent even after 73 days.

Drying corn at low temperatures reduces grain handling to a minimum and avoids delay in filling bins. The grain is virtually free of stress cracks and has the appearance of field-dried corn. — *Gene C. Shove*

New Easy Peeling Tomato Promises to Be a Boon for Housewives and Processors

Peeling tomatoes is at present a time-consuming step for both the housewife who is preparing tomatoes for cooking and for the processor who is preparing them for whole-fruit packing.

The housewife ordinarily has to scald the fruits in boiling water to loosen the skins from the flesh of the fruit. Processors peel tomatoes chemically with a hot caustic soda (lye) solution. Additional lye must be added periodically to maintain the desired concentration, and a certain amount of spent solution is continually discharged into the sewers. Even if the processor neutralizes the alkali solution before discharging it, the resulting sodium salts contribute to water pollution.

A new tomato mutant recently discovered in the Netherlands holds great promise for minimizing the problem of peeling tomatoes. Fruits of the new type, called "easy peeling," are remarkably easy to peel without immersion in hot water. Usually only about four skin fragments result from peeling the new tomatoes, as compared with about 16 skin fragments when normal tomatoes at comparable maturity are peeled.

Discoverers of the mutant have shown that the character is conditioned by a single recessive gene, which will make it easy to incorporate the character into commercially acceptable varieties.

The current easy peeling material has relatively small fruit and appears to be somewhat susceptible to fruit cracking. Work is in progress at the Illinois Agricultural Experiment Station to incorporate the easy peeling character into lines with high levels of crack resistance.

Additional research is in progress to combine this new trait with genetic factors that increase both the toughness and elasticity of the tomato skin, thus making the fruit suitable for mechanical harvesting. — *A. E. Thompson*

FARM BUSINESS TRENDS

RISING interest rates affect the farm business in several ways. They immediately increase farm production expense and thus tend to reduce net farm income. They also tend to depress prices of farmland. Eventually, however, they will increase the rate of return, or profit, from agriculture.

The rise of interest rates in recent years is primarily the result of inflation. Saver-lenders demand a higher return to compensate for the shrinkage in the buying power of money. Borrowers are willing to pay more interest because they expect to repay the principal with cheaper dollars.

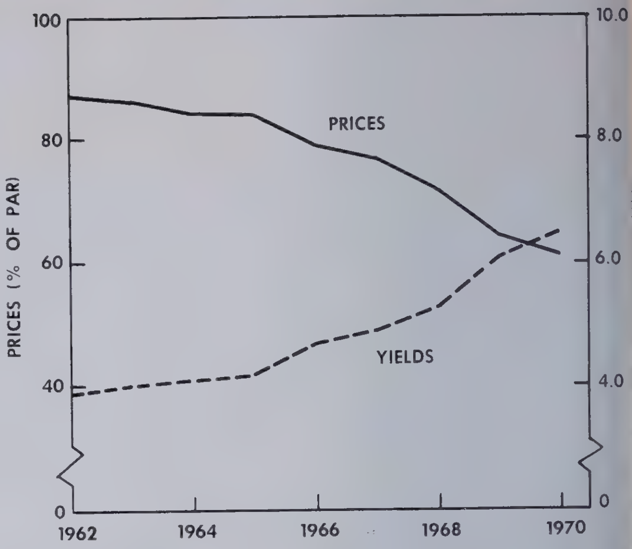
Interest rates, like prices of corn, are determined in competitive markets. Banks and other credit institutions are dealers in money. They pay competitive prices to get funds — which they loan to borrowers, again at competitive prices.

Efforts to restrain inflation have not been and probably will not be successful. Hence, interest rates will continue at relatively high levels.

Farmers' interest bills this year will total nearly \$3.5 billion, up more than 60 percent since 1965. The U.S. average cost per farm will be about \$1,200, but will be much larger on many Illinois farms.

Higher interest rates tend to depress land values in two ways. First, they make it more difficult for farmers to meet interest charges on mortgages, thus reducing the prices that farmers are willing to pay for land. Second, as yields on money in savings accounts, bonds, and stocks increase, land becomes less attractive as an alternative investment unless prices come down.

The chart shows how prices of long-term government bonds declined as interest rates rose. Prices of common stocks of corporations also declined sharply,



U.S. Government long-term bonds: prices and yields, 196 1970. (Figures for 1970 are estimates.)

raising the yield on market values of the stocks. Pric of farmland may also decline, which would tend raise the rate of return on the market value of farm land. For example, consider land that produces net return of \$24 an acre. With the price of land \$600, the yield is 4 percent, but if the price falls \$400 the yield would be 6 percent.

As economic concepts interest and profits are t same thing — or at least closely related. They tend rise and fall together, and to equalize in the long ru Thus higher interest rates will tend to increase profi earned by capital invested in businesses, includi farming. This is because very little new money will invested in farming unless the total return (current turn plus appreciation) is comparable to interest rat

— L. H. Simerl, Professor of Agricultural Econom

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Agriculture, environmental quality, and human interaction

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE Volume 12, Number 4

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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THE COLLEGE OF AGRICULTURE COUNCIL ON ENVIRONMENTAL QUALITY

A new approach to interdisciplinary research was inaugurate[d] April, when Dean Bentley appointed the College of Agricu[lture] Council on Environmental Quality.

Traditionally, the College has been organized into departmen[ts re]lated to some phase of the agricultural industry. Each departmer[t] encompassed several scientific disciplines, with interdisciplinary res[earch] being conducted within the departments. This organizational pa[ttern] has been highly effective in solving problems of agricultural produ[ction].

However, no universally successful model exists, either on this ca[mpus] or elsewhere, for conducting research by teams of scientists from t[wo or] more departments. In the past, interdepartmental research has [been] arranged primarily on a person-to-person basis to deal with the [tech]nical details of a particular problem. Administrative involvemer[t has] been minimal.

While such informal arrangements have often been satisfactory[, they] are not adequate for solving many of today's problems, which re[quire] sizable funding and relatively large numbers of people. The enta[ngle]ment of administrative lines could seriously hamper interdepartm[ental] research on the large issues of the day.

One such issue is, of course, that of environmental quality and [agri]culture. This was the area chosen for trying a new "two-dimensi[onal"] administrative structure recommended by the faculty in its long-[range] planning report. The traditional departments represent one dim[ension] of this structure; the Council on Environmental Quality constitut[es a] second dimension.

The council is composed of the chairmen of various task group[s that] were organized, with the permission of all department heads, to [study] specific problems of environmental pollution. Council membe[rs are] committed to research on these problems, regardless of the depar[tment] to which they belong. The council will determine new directi[ons for] research, evaluate proposed research projects on environmental q[uality], recommend methods of funding, and seek grants. It is hoped th[at the] new administrative structure will eliminate administrative ent[angle]ments in the conduct of vital interdisciplinary research on the [many] problems related to environmental quality. — *G. W. Salisbury*

MPROVING ENVIRONMENTAL QUALITY

A Major Goal of Agricultural Research

'. R. BOGGESS and R. J. MILLER

WHEN MAN was new upon the earth, he occupied a small niche the total life of the world. His eeds were so small that the essenals for life cycled freely on the earth id in the atmosphere.

As his brain evolved, man learned bypass the slow, natural processes inventing nonliving machines, not alizing that they would eventually mpete with himself for sun-fixed rbon and plant-liberated oxygen. nis process accelerated rapidly when learned to transpose the potential ergy of fossil fuels into the physical ergy of movement. In the United ates, this technology has provided e of the highest living standards in e world. At the same time man, ong with his industrial and agricultal enterprises, has degraded the , soil, and water upon which he pends for existence.

Agriculture has perhaps utilized odern technology more efficiently an any other one segment of the nerican economy. But heavy crop tilization, pesticide use, and failure use soil-conserving practices have contributed to environmental deioration. Decreased manpower eds have caused population shifts m rural to urban settings. Thus ile man has gained by being well and clothed, he may have lost t of his heritage in the process.

re knowledge is needed

The need to cope with the environnt is not new but has become more te as our population and its rerements increase. Environmental cepts have changed radically to ude not just air, soil, and water, also social, cultural, and economic surroundings. These revised concepts require new theories, more sophisticated research, and precise knowledge if environmental quality is to be improved and maintained.

Goals that should be sought are easy to state but hard to attain. We need to get maximum benefits from existing facilities and provide for the most efficient use of both natural and human resources. The approach must be truly multidisciplinary and involve meaningful communication among a number of specialists.

Basic research is needed to provide evidence of relationships among complex variables in our ever-changing environment. Priority systems are needed for allocating scarce resources. Information about environmental problems and their control must be widely disseminated, especially to those whose actions influence the environment. The apparatus for rational planning will have to be created. The view that science alone can provide both the solutions and their implementation is a false premise. Choice and action follow knowledge, but they are all too often confounded with the politics of resource planning and use.

In a purely economic sense, the cost-benefit ratio is often used as the single criterion for determining the feasibility of programs with long-range consequences. Cost becomes an unrealistic variable, however, when environmental quality and possibly the survival of living organisms are at stake.

A new emphasis

The College of Agriculture, while continuing its traditional lines of research, is also putting a new emphasis on research in the areas of environmental quality and human interaction. Our basic concern is to insure clean air, pure water, and productive soil, and to provide essential food and fiber in a setting that is satisfying and inspirational to the human spirit.

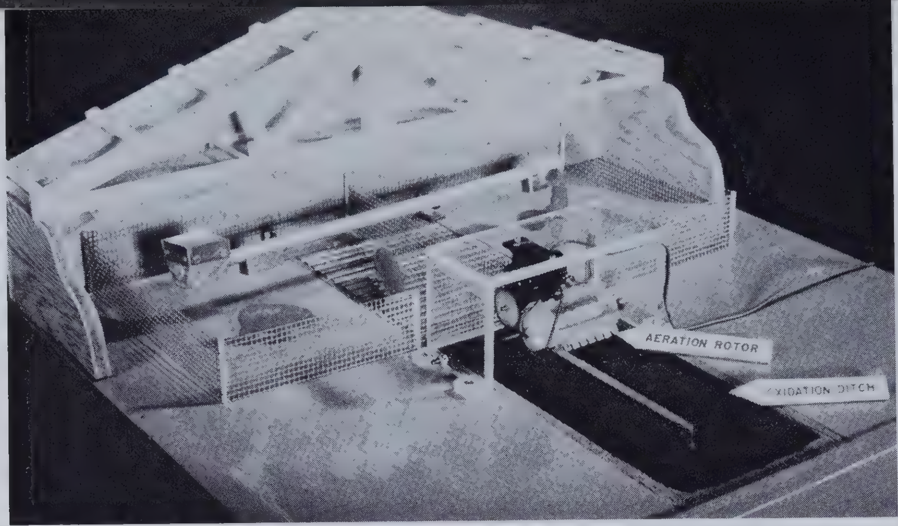
Some of the departments in the College have reoriented their objectives to place greater emphasis on environmental problems and their solution. The work done in the various subject-matter disciplines will be coordinated by a College of Agriculture Council on Environmental Quality.

The College of Agriculture is peculiarly well fitted for studying the causes and effects of environmental changes and the interaction of these changes with human welfare. Within a single administrative unit the College encompasses a variety of disciplines — pure and applied sciences, economics, sociology, and environmental aesthetics. It has an administrative structure for implementing research through the Agricultural Experiment Station and for disseminating this knowledge through the Cooperative Extension Service. Traditionally the College has integrated basic and applied research, and translated the results into action programs.

In determining the necessary steps for improving and maintaining environmental quality, university staff members have another great advantage — the freedom to be objective without economic or political pressures. Above all else, the universities are capable of training students who are genuinely concerned with man's physical and social environment.

The articles on the following pages deal with some of the problem areas in which the College is either conducting or proposing research. They will, it is hoped, give the reader some perspective on the problems and the ways in which the College hopes to contribute to their solution.

R. Boggess is Head of the Department of stry; R. J. Miller is Assistant Director of Agricultural Experiment Station.



Model of early experimental swine ho- ing, with partially slotted floor and e of the first oxidation ditches in the co- try. Since this housing was built, a totally slotted floor has been found pr- erable to a partially slotted one.

ANIMAL WASTE DISPOSAL
Becomes a More Difficult Problem

S. L. SPAHR

BACK IN THE DAYS when almost every small farm had a few cattle and pigs, disposing of the manure was only a routine chore. But for the modern specialized livestock producer, who raises hundreds of animals on a small acreage, manure disposal is a serious problem. In fact, it is a major factor in keeping many livestock units from becoming even larger.

The trend toward bigness in livestock production has been accompanied by a trend toward confinement housing. Producers find that raising animals in confinement reduces labor and also saves on bedding costs, as animals stay clean with relatively little bedding. A convenience for many small operators, confinement housing is often a necessity for large operators, simply because of the size of their feeding and management operations.

Many new housing facilities are designed with pit storage of manure. In a typical facility the manure drops through slots in the floor or is scraped into pits. It is handled as a semiliquid or slurry since little or no bedding is mixed with it. The pits are emptied every two or three months, and the liquid manure is spread on the fields. In some storage pits, the waste may be digested or treated continuously.

S. L. Spahr is Associate Professor of Dairy Science.

Several hazards

Despite the advantages of such systems, they may create serious health and pollution problems. Leaching or runoff may cause water pollution if a heavy rain occurs soon after several months' accumulation of manure is spread on a field. Spreading the manure on snow or on a frozen field increases the danger of pollution due to runoff. Water pollution may also be caused by an overflow of the storage tank due to inadequate water diversion, or by percolation into underground streams.

In many cattle feedlots the manure from hundred of animals is simply allowed to accumulate until it can be hauled away and spread on fields. These feedlots may be serious sources of water pollution, especially during rainy weather, if they are not designed to prevent stream contamination.

Another serious problem caused by accumulation of animal wastes is that of odors and gases. When manure is stored in pits in a liquid form for several weeks, an anaerobic type of fermentation occurs, producing large amounts of ammonia, carbon dioxi-, hydrogen sulfide, and methane.

These gases not only smell bl, but they are actually dangero. Methane and ammonia may be p- duced in large enough amounts o cause explosions. Ammonia and - drogen sulfide may be health haza s to both man and animals. Odors a hazards are especially great when e manure is being agitated during st- age to prevent settling out of the s- ids, and when it is being spread n the fields.

According to a 1969 report by e Secretary of Agriculture, ani l wastes in the United States proba y exceed wastes from any other segm t of our agricultural-industrial-c- mercial-domestic complex. Ev y year, animals produce an estima d 1.7 billion tons of waste, of wh about one-third is liquid.

A 100-pound hog produces ab t a gallon of waste (urine and fec) daily. This is as much as is produ d by two humans. A 1500-pound d y cow produces 15 gallons a day, o s much as is produced by 30 hum s, while beef cattle daily produce ab t 10 gallons per head.

The magnitude of the problem n Illinois is illustrated by the follo g figures: In 1966, 216 farms, or 8 percent of the total farms marke g fed cattle in Illinois, marketed 2 - 000 head, or 15.5 percent of the - nois total. The cattle on these 6 farms produced as much waste a city of 4 million people.

The pollution problems due to - mal wastes aren't quite as bad as e preceding comparisons indicate, animal and human wastes diffe n the amount of oxygen required o degrade them. Animal waste h a somewhat smaller biochemical - gen demand (BOD) per unit of - ume than does human waste.

tle knowledge available

The design of equipment and facil-es for handling animal waste in a uid form is relatively new. Most ch facilities in the United States ve been built since 1964. Because this newness, our knowledge lags behind our needs.

Much of the first engineering re-rch was directed toward designing avy-duty equipment and facilities t would stand up under large ume usage. The development of tems that would solve the poten- problems due to odors and water lution generally has been slow. build such systems requires knowl-e in several disciplines. Adequate logical data concerning such fac-s as the effect of diet on rates of radation, control of fermentation l products, and proper rates of ition simply are not available.

urthermore, these systems are ex-sive. The livestock producer can- charge more for his product ply because his production costs e been increased by the cost of te disposal for pollution control. thus has little or no economic ntive for incorporating waste dis-al facilities into his production .

erent disposal methods

everal approaches have been tried disposing of animal waste. The t common method is to return the es to the land, thus providing their re-entry into the biological . Other approaches include an-bic decomposition of wastes in ons, heated anaerobic digesters, bic lagoons, mechanically aerated ons, oxidation ditches, dehydra- incineration, composting, reuse rocessed animal waste as animal , and irrigation with fresh animal e.

veral new pieces of equipment new types of facilities have been ned to meet the demand for ling animal waste as a liquid. e include high-capacity pumps ble of pumping some solids in ion to liquids, a plow-furrow- method of returning wastes to the land, flush systems in gutters, and special sprinkler heads for irrigation. Some of the approaches, such as oxidation ditches and controlled anaerobic digesters, have shown promise under experimental conditions, but have not been fully field-tested.

Research work in this area has been largely developmental engineering, with the main responses tested being the reliability of the equipment, its ability to control odors, and the effect of the system on the BOD of the waste. As already mentioned, very little research has been done on the biological side of the problem.

U. of I. research

Research workers in several departments of the College of Agriculture have been attacking the problems of animal waste disposal. The Departments of Agricultural Engineering and Animal Science have cooperated in several projects on the disposal of swine waste. Several years ago they built one of the first oxidation ditches in the country. Also, they have been trying to determine the proper use of lagoons and are seeking methods of controlling gases and odors in confinement hog housing. Agricultural economists have made several studies on the economics of handling swine manure as a liquid.

Research is now being done on the development of systems for the digestion of cattle waste. An experimental oxidation ditch for processing beef cattle waste, which was constructed in 1968, appears promising.

In related work, microbiologists in the Department of Dairy Science have conducted extensive research into methane production by bacteria. Ruminant nutritionists have studied many of the metabolic patterns for digestion of feeds by microorganisms. Often the results of these laboratory studies are directly applicable to the problems associated with animal waste disposal.

Research needs

Requests for information about minimizing water and air pollution from animal wastes have increased greatly the last few years. This demand has had a two-fold impetus: (1) The public is suddenly aroused about environmental quality and will no longer tolerate the polluting of our natural resources. (2) Livestock enterprises are rapidly becoming larger because of advances in technology and the ever tighter economic situation.

The greatest research need is to find alternate uses for animal wastes with a minimum of pollution, odors, and costs. Systems showing promise in the laboratory or with one species need to be tested to determine their effectiveness with wastes from swine, beef cattle, dairy cattle, and poultry. Differences in the fibrousness of diets and in the resulting feces; in management facilities; and possibly in economics of waste disposal for the different types of livestock mean that a system suitable for disposal of waste from one species cannot be recommended for another species without adequate testing. At the same time wastes from all species have many characteristics in common.

To design effective systems, engineers need additional information on the biological characteristics of animal waste. For example, while odors are a major problem in stored wastes, the chemical structures of the compounds producing the odors are largely unknown, thus preventing an understanding of their biological control. No satisfactory method has been developed for quantitative measurement of odors so that the effectiveness of different treatments may be evaluated quantitatively.

For the safety of the livestock manager and the animals, there is need for research concerning the conditions which favor the production of ammonia, hydrogen sulfide, carbon dioxide, and methane. Also, more needs to be known about the gases that may be produced in trace amounts.

It is apparent that the talents of scientists and engineers in many disciplines will need to be brought together in the effort to solve the problem of animal waste disposal.

The Utilization and Disposal of
MUNICIPAL SEWAGE WASTES

T. D. HINESLY

THE GROWING public demand for clean air and water means that more solids must be removed from the effluents of municipal sewage plants and that other disposal methods than burning must be found for these solids.

The solids separated from water during sewage treatment are a complex array of organic and inorganic residues called sludge. There are several kinds. The first is primary sludge, which consists of raw sewage solids collected during the first separation of solids from water.

The effluent from the primary settling tank is put into another tank where it is mixed with large quantities of aerobic microorganisms and large volumes of air. The microorganisms use the oxygen in the air to convert part of the organic waste into carbon dioxide and water to obtain energy, while converting another large portion into new cells.

The portion of the waste converted into new microbial cells is called activated sludge, which is not very stable and is hard to dispose of. Sometimes it is heat-dried and sold as a soil conditioner and fertilizer. Often, however, it is put into a heated anaerobic digester along with the primary sludge.

When introduced into the anaerobic digesters, the dry solids in the primary and activated sludge average about 70 percent organic and 30 percent inorganic matter. About two-thirds of the organic matter is destroyed during anaerobic digestion. The remaining organic matter is more stable than aerobic digested sludge and undergoes little further biological degradation. This greatly reduces the problem of disposal.

T. D. Hinesly is Assistant Professor of Soil Ecology, Department of Agronomy.

Methane gas, which is produced during anaerobic digestion, represents sludge stabilization since the gas is practically insoluble in water and escapes from the waste. The methane gas may be used as fuel.

Anaerobically digested sludge contains 3 to 5 percent solids as finely divided and dispersed particles. It looks like crude oil and has an odor which many people describe as earthy or tarry. It can be easily transferred by pipes using ordinary pumping techniques and equipment.

Land disposal is feasible

In the past a variety of methods have been used to dispose of digested sludge. These include storage in lagoons; dumping in the ocean; drying on sand for use as a soil amendment; and spreading on farmland.

As coastal waters become polluted and many large inland cities run out of space for lagoons, land disposal is expected to become much more important in the future. The feasibility of land disposal has been greatly increased by the use of heated anaerobic digesters. The waste stabilization achieved by these digesters eliminates obnoxious odors and fly breeding problems.

Land disposal is at present the least expensive method. Pipeline technological developments and unit trains of tank cars have made it economically feasible to transport the sludge over long distances. With present irrigation distribution systems, anaerobically digested sludge containing less than 10 percent solids can be applied to pasture and cropland with much less labor than was required a few years ago.

When applied to cropland at the rate of 2 inches per acre, anaerobically digested sludge does not create immediately obvious problems. Moreover, this amount of sludge will supply all of the major essential nutrients, including the following: 225 to 2 pounds of ammonium nitrogen per acre; about 300 pounds of organic nitrogen which will be slowly released in a form available to crops; 200 to 300 pounds of phosphorus (P_2O_5), of which about 80 percent is in the sludge organic matter; and 40 to 80 pounds of potassium. Sulfur would also be supplied in amounts adequate for crops. The amounts of calcium and magnesium supplied would exceed the average annual losses of these elements.

On soils very deficient in potassium, a supplementary potassium fertilizer may be needed for high yields. When available potassium is adequate, crops respond as well to digested sludge as to inorganic fertilizers.

Too much sludge to be utilized

Not all of the digested sludge can be utilized as fertilizer, however. For facilities producing several million gallons a day, the main emphasis may be on disposal rather than utilization. A number of economic considerations favor continuous disposal on one site rather than short-time disposal on numerous sites. Some regional sanitary districts may need a site of several thousand acres.

High application rates cause obvious problems. One is the possible increase of nitrate and phosphorus concentrations in the local water supply. To determine maximum sludge loading rates on soils, information is needed about nitrogen and phosphorus concentrations in surface and drainage water from areas treated with various rates of sludge.

It is also essential to study the impact of continuous sludge disposal

the ecology of an area. In particular, we need to determine how the release of measurable concentrations of various metals will affect living organisms. Major attention should be given to those trace metals which often occur at relatively high concentrations in sewage sludge and which are highly toxic if they accumulate in animals.

Sludge samples from the Metropolitan Sanitary District of Greater Chicago often contain higher concentrations of chromium, zinc, copper, lead, nickel, and cadmium than are found in typical agricultural soils. These metals will probably be the first to pollute soils, if the disposal of sludge on land does pose a real threat.

Behavior of trace elements

The behavior of trace elements in the soil and their uptake by crop plants are influenced by several factors. One of these is soil pH. Most heavy metal toxicities in terrestrial plants have been associated with a pH of less than 5. Liming soils can therefore control the uptake of most heavy metals.

Some heavy metals may form inert and insoluble compounds with clays and organic matter. Because digested sludge contains large amounts of stable organic compounds, trace elements may be less available than the concentrations of these elements would indicate.

Conversely, certain organic compounds associated with the decomposition of plant residues are water-soluble and often chelate heavy metals. This prevents the precipitation of these metals and makes them susceptible to leaching. Returning large amounts of plant residues to the soil may stimulate movement of trace elements to lower soil depths.

Reducing conditions (low oxygen concentrations) in soils may also contribute to leaching of heavy metals. Practices which promote better soil aeration, such as drainage and structural development, may decrease solubility of some trace elements.

When grown on the same soils, different species, and even different varieties of the same species, differ markedly in concentrations of trace elements. The selection of crops thus affords a control over the entrance of undesirable amounts of trace elements into food chains.

Increasing the concentration of almost any ion in the soil solution will eventually affect the rate at which plants absorb other ions in solution. It may also affect the rate at which other ions are translocated within the plant. Thus, plant toxicity due to a particular element may be the indirect result of excess amounts of some other element. It is possible that a particular trace element can be applied to soils to decrease the plants' absorption of another element.

A great need exists for assessing the interrelationship of waste disposal on cropland and trace elements in the food chain as affected by soil type, crop, soil management, and fertilizer practices.

Biological contamination

Although a disease outbreak has never been known to result from applying anaerobically digested sludge to land, the possibility of biological contamination of local water supplies must be considered. Anaerobic digested sludge as drawn from the digesters contains several thousand fecal coliform bacteria per milliliter. If the material is stored for about two weeks as in a lagoon, the fecal coliforms die off. About the same rate of die-off occurs if fresh digested sludge is applied on land surface. Thus, using fecal coliforms as an indicator, it seems safe to use lagooned sludge on crop land, although more information is needed about the application of fresh-drawn sludge.

A great deal of attention has been given to the effectiveness of sewage and water treatments in removing a variety of viruses, but no one has actually studied the survival of viruses in sludge after its separation from effluents. With the renewed interest in digested sludge as a fertilizer or soil amendment, there is an urgent need to know whether viruses can survive the digestion process. According to a current study, the chances of viruses surviving for 14 days in a heated anaerobic digester seem very slim. Many virologists believe that if viruses did survive in the digester, they would soon die away like fecal coliforms in lagooned material.

According to a few studies cestodes and parasitic nematodes probably would not survive the digestion process, except possibly for eggs of *Ascaris*. If parasitic nematodes did survive, they would be unlikely to withstand freezing weather.

U. of I. research

At present several aspects of sludge disposal are being studied by members of the Agronomy Department and others. These aspects include crop responses to sludge application; factors relevant to chemical contamination of water, soils, and crops; physical changes in soil properties; and factors affecting bacterial contamination of drainage and runoff water. Most of the research funds are being supplied by U.S. Public Health Service Bureau of Solid Waste Management and the Metropolitan Sanitary District of Chicago.

At present, much of the work is being done on a large and unique lysimeter facility at the Northeast Agronomy Research Center. The facility consists of forty-four 10- by 50-foot plots or lysimeters (see back cover). Each plot is lined to permit sampling of runoff and drainage water after various treatments. This sampling is done automatically after a given volume of flow. Treatments consist of four rates of sludge applications on three soil types. Corn is being grown on 22 of the plots; soybeans, on the other plots.

To determine how climate influences the effects of sludge applications on crop land, data must be collected for several years and the results correlated with long-time weather data. Similarly, the gradual changes in soil properties resulting from sludge applications are cumulative and may not become apparent for several years. It is therefore important to continue the study until such changes become evident or are found to be negligible.

INTEGRATED PEST-CONTROL SYSTEMS

Eliminate Overdependence on Pesticides

W. H. LUCKMANN

IT IS BECOMING increasingly clear that the standard of living attained in the various nations of the world is proportionate to their knowledge of modern agriculture. Luxuriant yields of food and fiber crops have resulted from the application of modern agricultural methods in technologically well-developed areas. Among the practices contributing to the high yields is the use of pesticides.

Of the crops grown in the North Central region, corn is the most dependent on the use of herbicides for weed control and insecticides for insect control. In 1969 corn production took 68 percent of all herbicides and 58 percent of all insecticides used in the 12 North Central states. Farmers in this region used about 55 percent, by value of sales, of all herbicides sold in the United States. Insecticide use was about 20 percent of the total used in the 48 contiguous states.

The heavy use of pesticides in the Midwest has been going on for nearly two decades. As a result, our environment, particularly the soil and water, has become contaminated with pesticide residues of varying magnitude and significance.

In recent years, public and scientific attention has been focused on the chlorinated hydrocarbon insecticides as causes of environmental contamination. Although herbicides have been largely exempt from public criticism, the total pesticide component of environmental pollution provides an attractive issue on which to focus attention, arouse emotions, and develop action programs leading to legislation prohibiting or regulating the use of pesticides.

W. H. Luckmann is Head of the Section of Economic Entomology, State Natural History Survey, and Professor of Agricultural Entomology.

Without question, we must be vigilant in our use of pesticides to avoid undue contamination of our environment. But we cannot avoid their use if we want to continue feeding our population and maintain high standards of public health. Rather, agriculture and public health will have to depend on pesticides for years to come. What we need is more research on various methods of pest control, including pesticides, and their effects on environmental quality.

Research achievements and gaps

Many aspects of pesticide persistence, degradation, and interaction with the environment have been studied by research workers throughout the country. The work has included the effect of soil factors on the persistence and bio-activity of pesticides, mechanisms of absorption and degradation by soil colloids, persistence of residues in or on plants, the translocation of residues within plants, and the metabolism of pesticides in animals.

This research has been extremely productive. It has developed a very impressive and useful mass of knowledge on pesticide contamination of crops, foods, feeds, soils, and animals, including humans. Important metabolites and derivatives of the major pesticides have been identified, and new ultra-sensitive equipment for detecting residues have been developed. Implications of research findings have resulted in major changes in the use of some pesticides in the Midwest and elsewhere.

However, these efforts leave certain questions unresolved, as was pointed out by the environmental pollution panel of the President's Scientific Advisory Committee; the Subcommittee on Science, Research, and Development of the House Committee on Science and Aeronautics; FW PCA's National Technical Adviso Committee on water quality criteri and other national groups.

Of particular importance and mc often overlooked are the subtle a pects of aquatic contamination wi pesticides. This contamination caused in part by progressive trar fer and magnification of a compour through plankton to small fish larger carnivorous fish and bir Classic examples are the food cha incident in Clear Lake, Californ and the contamination of La Michigan coho salmon with DDT excess of 7 ppm. Every effort mu be made to avoid similar incidents the future.

With the persistent pesticides co ing under increasing disfavor, a ch of less persistent chemicals is taki their place. There is a possibili however, that even these less pers tent chemicals may have undesira effects on the environment. Expr sions of public and governmen concern toward the less persist pesticides will inevitably follow if search is not done to evaluate th environmental impact and to deve well-documented pest-control p cedures that call for precise a judicious amounts of pesticides.

Phases of insect control

In general, there has been an ov emphasis on insecticides in entor logical research, and a similar emp sis on herbicides has characteri research on noxious weeds.

This overemphasis on insectic dates perhaps from the 1940's. P viously, insect control might b described as having been in a sub tence stage. Then with the deve ment of DDT and other synth pesticides, insect control entered exploitation phase, characterized

ıe alfalfa weevil (top left) can be con-
ılled by use of its wasp parasite (adult
d cocoon shown at upper right). At
ver right the wasp is being released on
farm in southern Illinois.

ectacular increases in crop yields d by insect-free fruits and vegeıles. Most chemical insect-control tivities are now in this phase.

Recently, however, the control of me insects has entered a crisis ase, which has been followed closely a complete economic breakdown the control program. The crisis ase is typified by increased dosages a pesticide, more frequent applições, reduced benefits, and often verse effects. The history of the ntrol of boll weevils and bollrms on cotton in Argentina, Peru, d California, and of corn earworms budworms on corn in California d Florida are examples. They have n well documented by California earcher Ray Smith.

Logically, pest control must go a new phase that might be med one of pest management or egrated control. This will call for integration of pesticides, paras, predators, diseases, crop rotaıs, resistant plants, and possibly er factors into one system of pest nagement. Optimum use will be de of pesticide chemicals by not ending usage beyond the collective nomic benefit of the components the system. Rates and frequency pesticide applications will be rected to permit weather, diseases, asites, predators, and resistant nts to exert the maximum ade effect on the pest.

As the result of recent Illinois research, an integrated program has been outlined for mite control in orchards. Early in the season, destructive mites are suppressed with a miticide. Predaceous mites, which appear somewhat later, develop on the suppressed population and provide excellent control the remainder of the season. The early miticide treatment is deliberately aimed at suppressing mites rather than eradicating them.

A similar program to synchronize the pest and its parasite has been developed for the alfalfa weevil and the wasp that parasitizes it. The program will give excellent control if the alfalfa weevil is suppressed temporarily during winter or early spring.

Research plans

A major portion of our future entomological research effort at the Illinois Agricultural Experiment Station and the Illinois Natural History Survey will be devoted to developing integrated management systems for a variety of pests. The biology of the pest and the ecological factors affecting it will be determined and the correct pesticide selected for the management systems.

Great emphasis will be placed on the fate of the pesticide. Part of our attention will be given to analytical techniques for measuring pesticide residues and degradation products in soil, water, plants, and animals. This will involve improving present techniques as well as devising new ones.

We will also conduct research to determine the fundamental physical, biochemical, and biological factors influencing the occurrence, persistence, and magnitude of pesticide residues, as well as the interaction between pesticides and other environmental inputs. Finally, we plan to describe and evaluate pesticide cycling through soils, water, and the food chain.

Plant Nutrients as Water Pollutants

How do we continue to get the maximum benefit from fertilizers without increasing the danger of pollution?

L. F. WELCH

During the past three decades a tremendous growth in the use of nitrogen and phosphorus fertilizers has greatly increased the potential for water pollution.

Between 1940 and 1968 the amount of nitrogen fertilizer applied in the United States increased from about 378,000 tons to more than 6,500,000 tons. During the same period phosphorus increased from about 1,338,000 tons (P_2O_5) to 4,329,000 tons.

The increase in fertilizer usage was greater in Illinois than in the rest of the country. In 1940 Illinois used only 0.5 percent of the nitrogen fertilizer applied in the United States. By 1968, Illinois's share of the total had risen to 9 percent. Phosphorus used in Illinois accounted for 0.8 percent of the U.S. total in 1940; 9.8 percent in 1968.

The use of inorganic fertilizer has, of course, helped us to meet the challenge of producing enough food for an ever-increasing population. But the hazard of water pollution, which may be accentuated by the accelerated use of fertilizer, confronts agriculture with a serious question: How do we continue to increase food production without also increasing agriculture's contribution to water pollution?

The increased use of fertilizers only indicates potential sources of pollution. We cannot assume that fertilizer contribution to pollution has increased in direct proportion to usage. But neither can we make the opposite assumption.

The truth is that no one really knows the change in fertilizer's contribution to water pollution during the past 30 years. There is also uncertainty about the tolerances which can be allowed before the contribution becomes serious. Few agriculturists will deny, however, that the contribution will become greater if present trends continue. And there is every reason to believe that fertilizer usage will continue to increase.

L. F. Welch is Professor of Soil Fertility, Department of Agronomy. B. A. Jones, L. T. Kurtz, and S. W. Melsted contributed valuable suggestions to this paper.

What happens to applied fertilizers?

About 30 to 70 percent of the applied nitrogen fertilizer is absorbed by the immediate crop. The unabsorbed nitrogen may be immobilized in organic form or it may be converted into nitrate. The nitrate is very soluble and, being an anion (negatively charged ion), is not adsorbed by the soil particles. Thus as water moves through the soil, nitrate is very susceptible to leaching.

Between 10 and 20 percent of fertilizer phosphorus is absorbed by the immediate crops. Unabsorbed phosphorus usually forms slowly soluble calcium, iron, and aluminum compounds that are not readily leached except on sandy soils. Erosion of soil particles with adsorbed phosphorus is likely to be more of a problem than leaching of phosphorus.

Leaching of nitrogen may become a problem from the standpoint of both health and eutrophication. (By eutrophication we mean that excessive accumulations of a nutrient in a lake or pond will support a dense growth of plant and animal life, which, as it decays, uses up the oxygen supply in the water.) Leaching or erosion of phosphorus would be a problem from the standpoint of eutrophication only.

Current and proposed research

Research on the interrelationship between fertilizer and water pollution is so important that much effort is needed from many places. Various aspects of the problem are now being studied at other institutions. Many of these studies were initiated recently and results have yet to be published.

Certain basic concepts can, of course, be developed and applied anywhere. However, because leaching of nutrients depends on soil characteristics and climate, results of a field study in one area cannot be correctly applied to another area. Studies on a silt loam soil in Georgia, for example, might give quite different results than a study in Illinois. Since Illinois soil now receives almost 10 percent of the nitrogen and phosphorus fertilizer used in the United States, it seems imperative that research be conducted where so much of the fertilizer is used.

At the Illinois Agricultural Experiment Station, a number of studies are, or soon will be, under way to determine how nitrogen and phosphorus fertilizers affect the accumulation of these elements in our soils and water supplies.

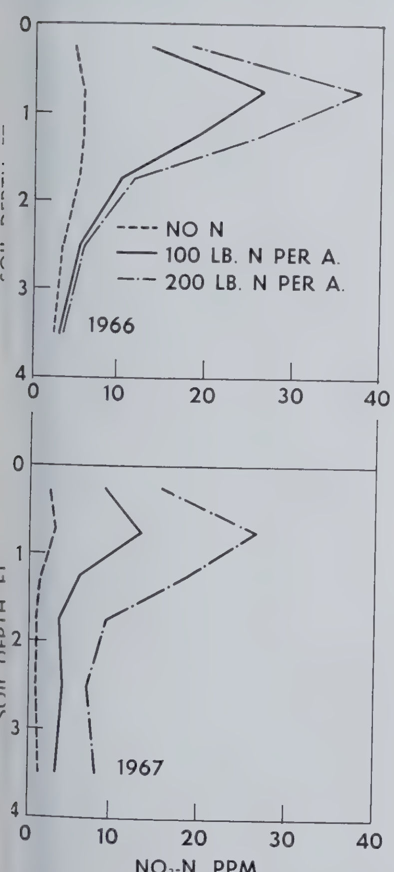
Several studies will be conducted on the experiment fields maintained by the Agronomy Department in major soil associations throughout Illinois. Cropping and fertilization history has been recorded for these fields since they were established—some of them 40 to 50 years ago. Rates of 0, 80, 160, 240, and 320 pounds of nitrogen per acre have been applied to some of the plots for several years.

These plots offer a unique opportunity to study nitrogen distribution

the soil profile, as affected by eatment variables. Since the Agronny Department will probably conıue to maintain the experiment ›lds, bench marks can be established determine changes with time.

The chart below shows nitrate-N :cumulations in the soil profile at ıe location after varying applicaıns of nitrogen. As would be ex:cted, the nitrate-N content of the il profile increased with increasing tes of application. The soil was mpled before the corn crop was anted in 1967. If it had been ımpled in the fall, the nitrogen ntent would no doubt have been wer.

After two applications of nitrogen ·tilizer, some nitrogen had apparently moved to the 3.5-foot depth. Corn roots can penetrate below 4 feet and absorb nitrogen from this depth. On the other hand, if the deep nitrogen is not absorbed by corn plants, it may move still deeper into the soil and eventually show up in our underground water supplies. These uncertainties need answers.



N·ate-nitrogen content of the soil profil as affected by the rate of fertilizer niıgen added. The fertilizer was added in he fall as ammonium sulfate, and the so was sampled the following May. Si e the same plots were used both ye s, the 1967 results show the effects of tw years' applications. (Data provided by . D. Hughes.)

Plans are also being made to study the nitrogen content of water from some of the experiment fields. Pipes with open ends will be vertically installed to depths of 2, 3, 4, and 5 feet on plots that receive various rates of nitrogen. The pipes will serve as a means of access to the water table. Water will be pumped from the pipes, permitting "new" water to enter the pipes from the various depths. The "new" water will then be sampled and analyzed to determine variation in nitrogen content with depth of water table.

Another proposed study is to compare the nutrient contents of surface runoff water and of water that percolates through the soil and is discharged by tile. This will be done in connection with an ongoing study by the Agricultural Engineering Department, wherein the runoff is being determined from 45- and 63-acre watersheds on the Allerton Trust Farms.

Tile water from farmers' fields with a known fertilizer history will be analyzed for nutrient content. Preliminary studies are now being made. The nitrate-N content of water from three tiles has ranged from 3 to 17 parts per million and the phosphorus content, from 0.01 to 0.10 parts per million.

The amount of fertilizer nitrogen absorbed by plants during three years of cropping has been measured. Present studies are aimed at determining the organic form of the fertilizer nitrogen that was not absorbed by plants.

Another problem is whether nutrients released from plant residues during the winter contribute to water pollution. To help answer this question, nutrient contents of plants will be determined at physiological maturity and periodically thereafter.

The feasibility of using nitrification inhibitors to help keep nitrogen in the form of ammonium will be investigated. Also, frequent application of small quantities of nitrogen will be compared with large single applications.

Phosphorus adsorbed to soil sediments in lakes and streams is being measured. Interest is focused on forms of phosphorus that may contribute to the supply available for uptake by aquatic plants.

Many studies are being conducted to determine economically optimum rates of fertilizer for corn and soybeans in Illinois. These studies are extremely valuable in helping to determine fertilizer rates that will be used in the near future.

Other needed research

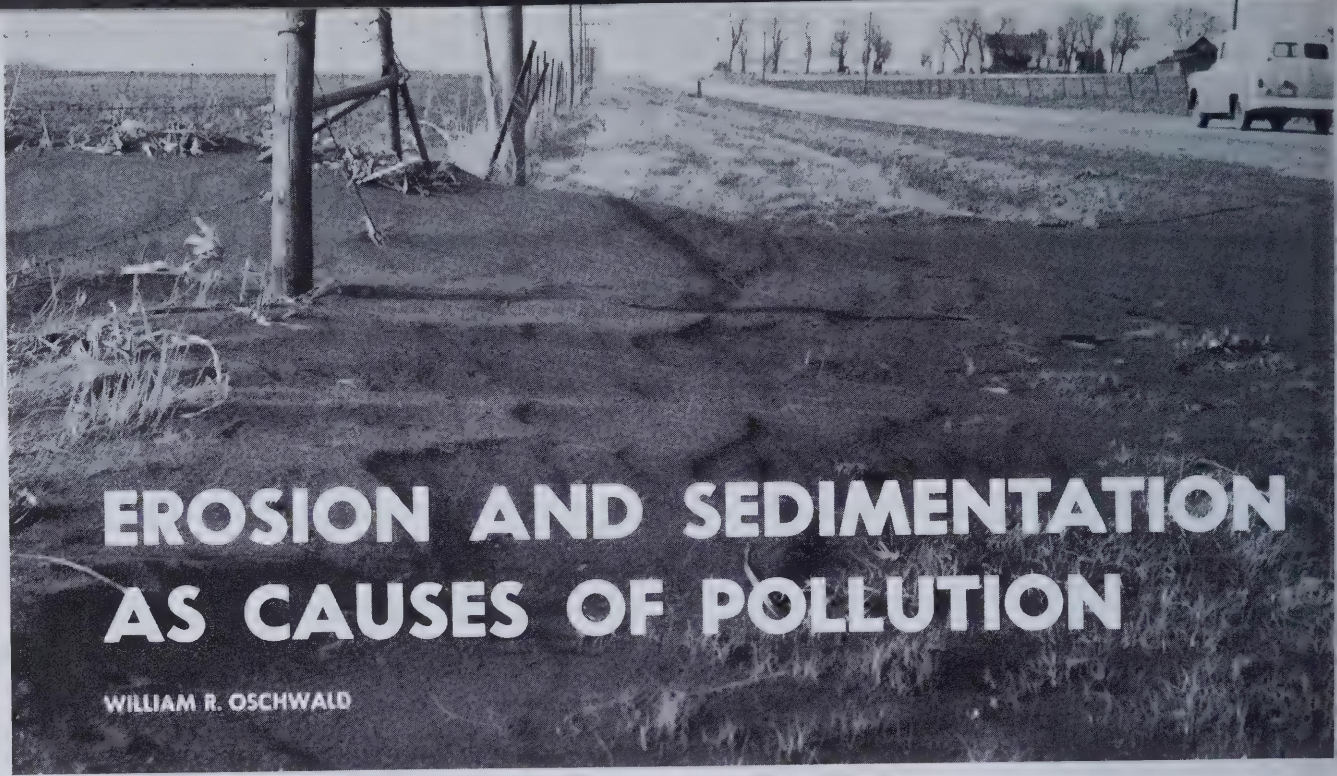
Many other problems need attacking. Slowly soluble fertilizers, especially nitrogen fertilizers, need to be developed. The ideal fertilizer would release nutrients to the soil solution just shortly before they are needed by plants.

The monitoring of streams and lakes for nutrient content should be expanded to include some water that travels mostly through agricultural areas; some that originates primarily from urban and industrial areas; and some that flows mostly from grassland and woodland. These studies should last long enough to establish trends in nutrient changes.

Means of removing nutrients from water should be investigated. Can nitrogen be made to volatilize from water? Can phosphorus be precipitated or adsorbed on solid particles?

Research is also needed to determine how agronomic practices affect nutrients entering streams. These include such practices as crops grown (corn, for example, normally receives nitrogen but soybeans do not), source of fertilizer, and time, rate, and method of application.

The preceding summary of ongoing, proposed, and needed research offers some idea of the complex, many-faceted problems that need to be solved in determining the effects of fertilization on water pollution.



EROSION AND SEDIMENTATION AS CAUSES OF POLLUTION

WILLIAM R. OSCHWALD

Soil erosion by wind and water has been recognized as a major land-use problem in the United States for over 40 years.

At first, the primary concern was for the reduction in soil productivity. Severe soil erosion resulted in what appeared to be the permanent loss of the soil resource. The "dust bowl" of the 1930's is a vivid example of the effect of erosion on man and the soil.

Since then, technology has lessened the impact of erosion on some soils. When combined with other crop production practices, commercial fertilizers may provide an effective substitute for surface soil on soils that are free of root-restricting layers.

However, production costs increase as plant nutrients are purchased and applied to replace those removed by erosion. And no amount of nutrients can repair the damage to soils with root-restricting layers at shallow depths. These soils are permanently damaged by severe wind and water erosion. Thus, although the technological revolution has lessened the depletion of soil productivity by erosion, it hasn't removed the problem.

Now a new concern is receiving national attention — concern about the quality of the environment. Society's concept of a quality environment includes outdoor recreational facilities, wildlife, scenic beauty, clear water, fresh air, and ample open space in which to escape from the problems of life.

Environmental quality is downgraded in many ways by wind and water erosion. Silt deposited in lakes, reservoirs, or streams reduces their water-holding capacity and impairs water quality for recreation and wildlife. Dust deposited on highways and in drainage ditches, homes, and offices means a costly removal problem. Blowing soil reduces visibility and is a highway hazard. Windblown soil may result in the deposition of pesticides where they are not wanted. Nitrogen, phosphorus, and pesticides in the soil may contribute to water pollution.

Besides damaging the cropland from which surface soil is removed, erosion may also reduce the productivity of land on which sediments are deposited. This happens when infertile soil material is deposited on top of productive bottomland soils during floods. Growing crops may be damaged by abrasion from drifting soils or by sediment deposition. Sedimentation may also fill up drainage ditches, thus reducing yields.

Sediment damages resulting from deposition of sediments from wa
have been estimated at $25,000,0
annually for the upper Mississip
River basin. (This basin has a drai
age area of 188,000 square miles a
takes in parts of seven states,
cluding all of Illinois except th
eastern portions that drain into
Wabash or Ohio River.) As sho
in the table, the $25,000,000 d
not include estimates for soil
pletion and wind erosion damages

Causes of erosion

Wind and water erosion is cau
by energy from wind, raindrop

Summary of Average Annual Sediment Damages in Upper Mississippi River Basin [a]

Type of damage or cost	Aver. an damag
Infertile overwash	$ 2,500
Crop yield reduction from impaired drainage	1,800
Reduction in channel capacity	700
Removal of sediment from drainage improvements	5,800
Damage to highways and railroads	8,800
Water filtration	300
Reduction in reservoir capacity	2,900
Dredging in navigable channels	2,200
Total	$25,000

[a] Source: Interagency Task Force on Sedim tion, Appendix G Fluvial Sediment in the Mississippi River Basin, United States Departm the Army, Corps of Engineers.
[b] 1960 prices.

William R. Oschwald is Associate Professor of Soil Classification.

act, or runoff that detaches and ansports soil particles. When the iergy for transportation is expended, ie sediment is deposited. Erosion is natural process and cannot be completely eliminated, but we do contribute to excessive erosion by our land-e practices.

The last 15 years have been a riod of rapid development and application of technology in corn and ybean production. As a result, several changes have occurred which ntribute to the problem of erosion. iese include the following:

- More intensive cropping of corn d soybeans.
- Larger farms with more acres r man.
- Larger fields as the result of minating hedge rows and consoliting small fields into tracts of 80, 0, or more acres.
- Large-capacity equipment inıding high-speed tractors and plows at result in a high degree of soil lverization.
- Increased pressure for fall plow-; as a result of the yield advantages earlier planting and the increased mber of acres per man.

These changes have increased the iciency of the corn and soybean oducer. They have also resulted cropping systems that leave bare, protected soil exposed to the ero-e action of wind and water from e fall until late spring.

The increased potential for erosion ; been of great concern to many ople. This concern is often exssed by the following questions: iat needs to be done to reduce erosion problem? What work has n done in the past? What work urrently under way?

iat needs to be done?

Effective erosion-control systems dify or protect the soil surface so t the energy of wind and water is ended before it results in damıg erosion. For systems to be efive, however, farmers must be ing to use them. This means that ion-control measures must be compatible with present crop-production patterns; otherwise, the patterns will have to be altered.

At present corn or soybeans are grown on about 70 percent of the cropland of Illinois, according to data from the Illinois Crop Reporting Service. Fortunately, conservation tillage systems, along with other erosion-control practices, can be compatible with the prevailing corn-soybean production pattern.

Development of alternative conservation tillage systems requires a more complete understanding of the erosion processes. We need to know more about the cause and effect relationships of raindrop impact, excessive tillage, wind, and other sources of soil detachment. The effects of field width and slope length on wind and water erosion also need to be quantified.

Such conservation tillage systems as chisel-plow systems and zero-tillage systems utilize crop residues to control erosion. However, the crop residues may introduce new problems. They may, for example, make pest control more difficult, or they may interfere with crop growth because of their effects on soil temperature or nutrient uptake. Farmers will be slow to accept these systems until the systems are modified or planned more carefully to reduce the undesirable side effects. We also need to determine how much crop residue is necessary and how it should be placed in the soil for erosion control.

What has been done?

Over the years, agricultural scientists at the University of Illinois have devoted considerable effort to the study of soil erosion and its control. In the 1940's, effects of contouring on runoff, soil loss, and crop yields were studied by Stauffer and others on the Agronomy South Farm. Runoff and erosion studies were also carried out in the 1950's at Joliet and Dixon Springs. Data from these studies, along with data from other states, were used to develop the Universal Soil Loss Equation for predicting soil losses from rainfall erosion.

Reduced tillage systems were investigated in the mid-1950's by Aldrich and later by Hinesly in the Agronomy Department. Bateman, Bowers, and others in Agricultural Engineering also conducted significant research on tillage systems. Although these studies have contributed to the concept of conservation tillage, the primary objectives were related to other aspects of the tillage question than the effects of erosion.

Studies on raindrop impact and soil erosion have been done in the Agricultural Engineering Department. Research on terrace design and spacing has resulted in the development of parallel tile outlet and other improved terrace systems.

Social and economic aspects of soil erosion and its control have been studied by Sauer, Swanson, and others in the Department of Agricultural Economics.

This listing of research in the area of erosion and its control is not complete but it does provide some indication of the inter-disciplinary aspects of the problem. Other important research has been and is being done.

Current research

Further study into the effect of raindrops and tillage operations on soil crusting is currently under way in the Department of Agricultural Engineering.

Tillage systems are being studied on the Agricultural Engineering Farm, the Agronomy South Farm, and at other locations in the state, including DeKalb, Elwood, Carlinville, and Dixon Springs. These studies are primarily concerned with machine development and modification and with plant growth. They could, however, be expanded to include more emphasis on erosion control.

Continued research on the erosion process and the complex interrelationships within the total crop production system will help Illinois farmers produce crops efficiently while minimizing the adverse effects of erosion and sedimentation.

Residues From Wood-Using Industries

New methods are sought for utilizing the huge volumes of waste generated in the manufacture of wood products

I. I. HOLLAND and T. R. YOCOM

Disposing of plant residues is often more of a problem for processors of agricultural and forest crops than for producers of these crops.

Nevertheless, on a nationwide basis, plant wastes resulting from farming and logging may impair the environment in two significant ways: (1) They may serve as reservoirs for diseases, insects, and other pests. (2) If they are burned — whether accidentally or as a method of disposal — the atmosphere is polluted with smoke, particulate matter, and hydrocarbons.

Forest fires alone, many of which originate on land with large amounts of logging debris, eject 160 cubic miles of smoke, 34 million tons of particulates, and 338,000 tons of hydrocarbons into the atmosphere every year. Uncontrolled forest fires also damage the environment in other ways — especially by increasing surface runoff of water and soil erosion.

In Illinois as a whole, the plant residue problems from crop production or from forest fires are not great because of advanced methods used in harvesting agricultural crops and the relatively small amount of forest land in the state. Forest wastes are problems only in local areas where timber acreages are concentrated.

Important problems do arise, however, in the disposal of residues from the state's food-processing and wood-using industries. The problems of the food processors are discussed on page 16. What we are concerned with here is the disposal problems of the wood-using industries in the state.

I. I. Holland is Professor of Forest Economics; T. R. Yocom is Associate Professor of Forestry.

Primary and secondary industries

Wood-using industries are classified as either primary or secondary. Primary wood-using industries produce the first marketable products from such items as sawlogs and pulpwood. Secondary industries take the products from the primary industries and convert them into such products as furniture, door and window frames, boxes, and crates.

At present the primary wood-using industries in Illinois are not extensive. They do, however, contribute to the total economy, providing a steady source of employment, particularly in the economically depressed areas of the state. In 1963, more than 5,000 persons employed in these industries added 48.1 million dollars to the value of manufactured products. Small sawmilling firms scattered throughout the state are virtually the only market available to most small woodland owners. Without this market, there is little incentive for improving the management and utilization of privately owned woodlands.

The secondary wood-using industries in the state are of much greater economic importance. Although current data are not available, we find that in 1958 the goods and services produced by these industries added 327.8 million dollars to the value of manufactured products.

The overall value of Illinois's timber-based activities (including growing, harvesting, processing, and distribution of wood products) was placed at 1.4 billion dollars, 5.5 percent of the total for the United States. Of the 3.4 million people employed in timber-based activies in the country, about 157,000, or 4 percen are working in Illinois. Among t states, Illinois ranks fourth (behi New York, California, and Penns vania) in the value of timber-bas activities and in the number of e ployees in these activities. Continu tion and expansion of such industr are thus important to the state.

Types of residues

The forest products industries ge erate large quantities of residu These may be divided into two ba types: (1) the raw bark produc when the logs are debarked for sa ing or chipping, and (2) the woo materials, consisting of slabs, edgin trim, sawdust, and shavings, that derived from the conversion of rou logs into standard square lum and secondary wood products.

The woody materials are again vided into two broad classifications coarse and fine. The coarse mater are the slabs, edgings, and trim t are potentially suitable for pulp ch or particleboard. The fines are mai sawdust and shavings.

In the primary wood-using ind tries, wood residues make up ab 50 percent of the gross volume of original log. A relatively small s mill cutting only some 20,000 bo feet of lumber a day will gene about 1,275 tons of bark, 1,700 t of coarse woody residues, and 2, tons of fines during a year.

The secondary wood-using ind tries also generate large quanti of wood residues. Few firms, h ever, have much data on the act loss of volume resulting from t operations. This loss is estimated 30 to 60 percent of the board-

ne potential use of bark residues is to stabilize the soil on roadside cuts. Here a ›wer is used to apply shredded bark to an exposed cut bank.

lume of the incoming dimension d lumber stock, depending on the oduct and plant efficiency. Accord- g to a recent survey, only 30 per- nt of the secondary wood-using ms in the state use even a part of eir wood residues, and this is mainly fuel. The residues utilized in this y amount to about 1 billion board t of lumber each year.

Nationwide, the unused wood resi- es probably exceed 1 billion cubic t annually. Disposing of these idues is a staggering problem. In past they were burned or were nped along streams and rivers. t neither of these solutions suffices we become more aware of the need halt the deterioration of our en- onment. Restrictions against burn- the residues are continually be- ing more stringent as communities pt measures for controlling air lution.

urthermore, many wood-process- firms have found that they can no ger operate efficiently without izing some return from the huge ounts of wood residues they pro- e. Economically sound means of izing these bark and wood ma- als are urgently needed.

Uses for residues are investigated

Some successful uses for bark and wood residues have been found — mainly in the western and southern regions of the country, where the major wood industries are located. One use for the coarser wood material in these areas is to chip it for pulp or particleboard manufacture. Some fine wood residues are used as a soil amendment or mulch. Bark has found expanding markets as an additive for oil drilling mud, a soil amendment, mulch, and decorative wall paneling.

In the Midwest, utilization of wood and bark residues is poorly developed. Pulp mills are growing in importance, and their problems are acute. Studies of two mills in Ohio and Indiana indicated that only 10 to 12 percent of the bark generated is marketed. In Illinois, almost no wood and bark residues are utilized at present. Because of differences in species, uses found satisfactory in other areas cannot be adopted by Illinois industries without additional testing here.

For the past two years, the Departments of Horticulture and of Forestry have joined in research to determine whether the hardwood bark produced by Illinois firms can be utilized satisfactorily. The project has received financial support from two pulp and paper companies, together with funds provided by the State Technical Services Act.

Three uses of bark are being investigated: (1) as a growth medium, replacing peat moss in the production of potted plants; (2) as a "balling" material for field-grown ornamental nursery stock; and (3) as a mulch and erosion-control measure in nurseries and highway construction. Results are encouraging, often impressive, and are generating much interest among suppliers and users of bark alike. (See ILLINOIS RESEARCH, Vol. 10, No. 4, and Vol. 12, No. 1.)

The Department of Forestry is also conducting a survey to determine the sources and amounts of bark residues produced in the state, and the potential users of these residues. Services of the Illinois Survey Research Laboratory are being utilized and bring to this study the most efficient and modern survey techniques currently available. A similar survey has just been initiated to determine the sources and volumes of wood residues produced by the state's secondary wood-using industries.

Research needs

We would like to expand the present work with bark, emphasizing its use as a mulching material and as a means of controlling erosion in highway and other types of construction.

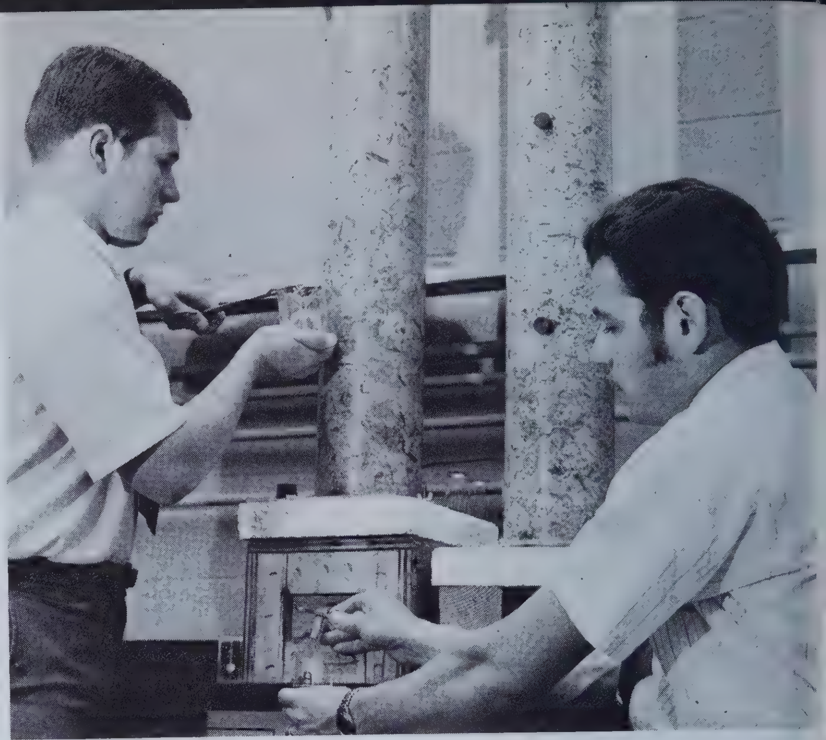
We also need to investigate the basic chemical composition of bark, products of decomposition, exchange capacity, and related questions. This has not yet been done, and such data are essential for finding the best ways of utilizing bark residues.

Another proposed research project is to investigate the use of wood and other plant residues in the making of particleboard, and to determine the strength and other characteristics of the finished product.

Solving the problem of utilizing wood residues will help the economy of Illinois as well as the battle against pollution.

Disposal of Wastes From the Food-Processing Industry

M. P. STEINBERG



Graduate students Kenneth Palmer and Dan Abruzzo study disposal of solid wastes from sweet corn canning operations. The liquid seeping out of the bottom of a pile has a BOD of 100,000 ppm (as compared with 10 ppm for effluent from a municipal sewage plant), so this material can easily pollute streams and underground water.

THE FOOD-PROCESSING industry generates a staggering amount of solid waste each day as it converts the raw products of our farms and oceans into usable forms, then preserves the finished products by canning or other means.

For instance, 60 percent of the lima bean, beet, and pea material brought into the processing plant becomes solid waste, while only 40 percent actually goes to the consumer. Wastes represent more than one-half of the starting weight of 11 common horticultural products.

The food industry of the United States produces a BOD (biochemical oxygen demand) waste-load that is four times that of the sewered population. Only one waste from one industry — cottage cheese whey — is equivalent to the domestic waste from 83 million people. Waste from the meat-packing industry is equal to that from twice the metropolitan Chicago population.

The fruit and vegetable canning industries produce waste with a BOD equivalent of 8 million people. This figure is based on annual production rates. During the late summer and the fall the daily outpouring of waste would be about 10 times as great, with a BOD waste-load equal to that of 80 million people.

Illinois engenders more than its share of food industry wastes because it has so many food-processing plants. It accounts for about 10 percent of all food processing done in this country.

Food industry wastes generally share a characteristic that magnifies the disposal problem — they are wet. The moisture percentages of a few representative foods are as follows: apples, 85; carrots, 88; pumpkin, 91; sweet corn, 73; lean beef, 80; fish, 75. Furthermore, the solid wastes produced by a food-processing operation are carried away in a stream of water. Therefore, incineration of food wastes is not economically feasible, and biological disposal methods must be used.

Current research on the national level is miniscule, considering the magnitude of the problem. Small companies lack resources. Large corporations hesitate to expend funds that will benefit the entire industry. This leaves the problem to associations, government laboratories, and universities.

The National Canners Association, Berkeley, California, is working on problems of the fruit-canning industry. Researchers there have developed an economically successful process for making charcoal briquets from peach pits. They are also investigating the composting of waste products and disposal at sea. The agricultural experiment stations at the Universities of Maryland and Wisconsin have projects on conversion of food wastes to feeds or to stabilized organic matter.

Research is needed to help the food industry of Illinois find better means of waste disposal than dumping the waste into streams and rivers or sending it to already overloaded municipal sanitary systems. The place to start is the point where the solid waste is generated, such as the peeling machine. Engineering studies are needed to determine how the wastes may be economically segregated and collected. Biochemical studies are needed to determine how the material can be stabilized. Biological studies are needed to determine how the material can be converted into a useful product — a food, if possible, or a feed.

Right now, at the University of Illinois, we plan to concentrate on sweet corn wastes. We hope to stabilize and, if possible, beneficiate these materials so they can be useful food ingredients. Such an investigation should serve as a pilot study in that the procedures developed and results obtained would indicate what could and should be done with many similar food plant solid wastes.

M. P. Steinberg is Professor of Food Engineering, Department of Food Science.

DECISION-MAKING PROCESSES
As Related to Environmental Quality

EARL R. SWANSON

HE LEVEL of environmental quality is determined by the interac- n of men with their physical sur- undings. Problems arise as the re intensive use of our natural re- urces conflicts with our rapidly ng standards of environmental ality.

The core problems in management the environment are (1) to iden- the options for action with the ly consequences, both on-farm l off-farm, of each option; and to design the institutional sys- ns which will maintain or restore desired balance between the level environmental quality and the efit from technology.

Viewing the problems of pollution n the standpoint of management, Department of Agricultural Eco- nics plans to focus attention on ects of decision-making that are vant to environmental quality. isions about environment are le by large numbers of individuals organizations at different times. se decision-makers can be divided three groups: (1) the individ- or the business firm, (2) the l and bureaucratic systems which itate and constrain decisions le by the first group, and (3) the latures, public commissions, and courts.

ith these three decision-making ps in mind, the department will to both develop and publicize yses and information that will ove the foundation for public private policy. Teaching, re- h, and extension programs will be involved in the effort. Em- is will, of course, be on the prob- directly involving agriculture.

ividuals and firms

nventionally, micro-economic ses are used to determine the effect of new technological developments on an individual, either as a producer or a consumer. Such analyses need to continue as new pollution-control measures are introduced, so that farmers and consumers can make quick adjustments to the changes. However, the cost-return calculations must be modified so that results can be integrated into the more comprehensive benefit-cost analyses needed when off-farm (sometimes referred to as external, spillover, or third-party) costs and returns are considered. How these costs and returns affect various individuals and groups in the system is an important consideration in policy evaluation.

Several alternative methods may be used to influence individuals to modify their behavior so that the quality of environment may be improved. Polluters may be charged a fine, for example, and the damaged parties compensated. Another alternative is to tax the polluter. Informational programs may also be influential. The important question is how individuals, both as producers and as consumers, will respond to the incentives of each method. Estimates of such responses are essential in designing programs to achieve the desired level of environmental quality.

Legal and bureaucratic systems

Closely related to the need for estimates of individuals' response to the various incentive systems is another need — that for evaluating the structure and performance of the courts, taxes, and financial regulations which may act as incentives and as constraints upon individuals. For example, recent federal legislation has established standards for air and water quality. Which combination of regulations, financial incentives, education, and technical assistance is desirable for each of the agriculturally related pollution problems?

This question becomes especially pertinent in connection with the problem of feedlot pollution. Extension education programs have not been achieving satisfactory levels of control, and a new combination of methods must be found and implemented.

Although information on effective combinations of methods is needed for the entire range of pollution problems, efforts will be concentrated on three major areas for the time being. These are solid waste disposal, pesticides, and sedimentation.

Legislation and public policy

Public policy in the area of environmental management must recognize that decisions affecting the quality of the environment are made by large numbers of independent political and economic units. Further, the consequences of such decisions have an impact on many persons not participating in the decisions. The political decision-making process thus needs to include an efficient means by which interested groups are represented. The roles which government at various levels can best play in attacking specific environmental problems need to be studied.

Outcomes of alternative public programs are not always predictable because information either is not available or has not been adequately analyzed. This is especially true in the area of pollution control. There is substantial scope for the contribution of economic analysis to the problem of predicting consequences of various types of legislation dealing with environmental quality.

Earl R. Swanson is Professor of Farm Management and Production Economics, Department of Agricultural Economics.

Effects of a Rapidly Changing Environment on HUMAN HAPPINESS AND WELFARE

ESTHER L. BROWN, WILLIAM R. NELSON, JR., HAROLD H. ALEXANDER, MARGARET R. GOODYEAR and MICHAEL J. SPORAKOWSKI

THE UNITED STATES is so new-oriented and technological developments come so rapidly that little if any thought is given ahead of time to their effect *on man.*

Changes, sometimes drastic ones, are made in the environment without considering how man may react to long-time exposure to change; how technological changes may affect man's production and consumption of resources in the environment; or how these changes may disrupt the entire ecology of a region. Consideration of man's place within the total environment means concern for the survival of productive human beings within an environment that will provide a desirable quality of life over a certain span of years.

It is a known fact that man responds both psychologically and physiologically to his environment, but the intensity of his response is unknown. Nor do we know to what extent man is threatening his own survival by technological interference which may impede or disrupt nature's self-regulating mechanisms.

The need for systematically relating man-made environments to natural ecological systems is manifest. Interrelated with this need — and equally important — is the need to understand the effects of both man-made and natural environments upon human society and behavior.

Some of the obvious problems are the man-made ugliness of the environment, the destruction of natural beauty, lack of privacy, and inadequately arranged spaces inside and outside the home and other structures. These conditions constantly require man to adapt to environmental change and raise questions about human interaction with the environment. For example, how does the changing environment affect the unique values of individual and family life? And how has it affected the individual's ability to respond to stimuli (visual, aural, olfactory, tactile)?

One other question about the changing environment concerns its effect on human potentiality. Exploring human potential could become the meeting ground for a wide range of disciplines, offering a dynamic synthesis for seemingly divergent areas of research.

Research findings that indicate the point at which humans no longer respond overtly to unsightly and unhealthy aspects of the environment can provide the basis for new and innovative programs in resident teaching and Cooperative Extension. Such findings will also contribute to programs for improving the total environment.

Since work on these problems is so limited and in some cases new, it is difficult to give a perspective of research knowledge and needs. Instead, an outline of proposed research is presented in the following paragraphs.

Environment and the family

Assuming the family to be the primary unit of society, we must recognize that it acts, reacts, and interacts within the larger social-physical environment. This interaction yields implications for individual as well as corporate functioning.

In what instances does the family initiate action? What environmental factors inspire and facilitate such i-tiated action? Which are impe-ments? When is the family ac upon? Does the family adequat serve the functions attributed to Is today's family maximizing both dividual attainment *and* commun development?

Finding answers to questions su as these does not fall strictly with any one framework of study. Rath it will be necessary to tackle the pr lem through a number of separa but related, studies. Following six proposed lines of investigation

1. Study human response to and i teraction with the physical, psyc social, and interpersonal environm
2. Study especially the family a unit of response and interaction.
3. Study the criteria and meth used by the individual, the fam and other groups in making decis that affect the near environment.
4. Evaluate and assess the ef tiveness of the use of natural la scape elements to fulfill the hum requirements for identity and a se of place in the face of urban p sures, population growth, and te nological changes.
5. Identify people's beliefs, val and attitudes concerning the nat and artificial landscape as it rel to the home, neighborhood, and so that a framework of educa and public service can be establi to develop positive attitudes and havior toward the land and l scape.
6. Develop criteria for combi plants, space, and man-made m rials to provide meaningful, pro tive, and satisfying physical envi ments for human use. This wi apply both to the home and to lic areas.

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mall-town square (left) and a suburban shopping center (right) both provide pleasing space for people.

ificial environments and man

Man, as the inhabitant of artificial ironments created by human ef- s, is either the victim or the ben- iary of these efforts. We are now the midst of reshaping the envi- ment on an unprecedented scale, without a bridge across the sm that divides behavioral sci- es from natural sciences and the gn professions. We need a be- ioral basis for the designed use of ural elements (earth and plants) rder to develop artificial environ- its that provide for the social and onal well-being of man and for preservation of recognized values ne earth and its natural resources. he following list of proposals is nt to be illustrative, rather than austive:

Determine how the natural lscape (those elements of the scape important to people but ly utilized) can be integrated the artificial landscape (fre- ntly utilized elements).

Permit more realistic planning he design disciplines on the basis nformation about human atti- s, awareness, and response to ral elements.

Provide resource material for finitive public service program d at educating both youths and ts so that they will understand be aware of their environment, gnize good design, and realize how it can be applied to rural and urban developments.

4. Establish a basis for expanded teaching programs in nonagricultural uses of natural resources and in urban horticulture.

The methods of the "hard" sciences, which rely heavily on laboratory and field experiments, would not be applicable to this project. Rather, it would be necessary to employ techniques of the behavioral sciences. Specifically, the project calls for systematic observation by an investigator with a feeling for the nature of the setting and the people. He must be extremely sensitive to the structure of the environment, the processes that are taking place, and the general characteristics of the people using the space.

Selection and acceptance of environmental components

People use varied criteria when selecting objects for their environment — furniture, accessories, paintings, the houses themselves. Ideally, one would believe that function and design, along with cost, would be the dominant factors that people consider, but this does not seem to be the case. An insight into the reasons why one article of a particular design, make, or color will be selected instead of another of equal cost should be of great value in teaching housing, interior design, and environmental studies in general.

Insight is also needed into what makes people either accept or turn off what they consider the negative aspects of their environment.

The fact that the human being is capable of turning off that which bothers him, thus making life a little more bearable, has compounded the ills, both visual and physical, of our environment. The admirable qualities of our neighborhoods and rural areas are diminished by spreading "urban blight," and we human beings are aware for a while of what has gone, but soon apparently forget the loss. The process is repeated ad infinitum.

Eventually our environment becomes unbearable, and we must move or succumb. At what point did this happen? When did we turn off too much? Is a situation that we find unbearable still tolerable for others — others in another age group, another ethnic group, with a different level of education?

The attitude changes which occur as people become accustomed to a negative environment are indications of accepting or turning off that which is undesirable.

Investigations of these two points — people's criteria for selecting environmental components and the point at which the undesirable aspects of one's surroundings are accepted or ignored — are basic to the whole effort of improving environmental quality.

Overall view of the lysimeter facility at the Northeast Agronomy Research Center, which is being used to study utilization of municipal sewage sludge as fertilizer (page 6). Each of the 44 plots is lined with nylon reinforced polyethelene film from the 8-inch to the 6-foot depth. After planting, fiberglass roofing material is installed around the plots from the 8-inch depth to the surface. Fiberglass troughs at the end of the plots collect the surface runoff.

A UNIQUE LYSIMETER FACILITY

Water sampling equipment is located in the basement of the white building shown in the center of the preceding picture. Runoff water from each plot is separately piped to the equipment on the upper level; drainage water comes in at the lower level. Samples are taken automatically after a given volume of flow. Volume and rate of flow are automatically recorded on five 20-channel event recorders on the building's main floor.

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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The seaport of Chicago helps to make Illinois a top exporting state (page 16).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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G. W. Salisbury....................Director

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AGRICULTURAL ECONOMICS HAS NEW HEAD

From time to time in this column we would like to introduce some of the new administrators in the College of Agriculture. A recent addition to our staff is Richard Feltner, who succeeded Harold Halcrow as head of the Department of Agricultural Economics on August 1, 1970. Professor Halcrow had asked to be relieved of his administrative duties so that he could devote full time to teaching, research, and writing.

A native of Crawfordsville, Indiana, Professor Feltner began his academic career at Purdue University. He received his B.S. degree in 1960, having been voted the outstanding senior in the School of Agriculture, and his M.S. degree in 1961. A three-year Kellogg graduate fellowship took him to North Carolina State University, where he received his Ph.D. degree in 1965.

Upon completion of his work at North Carolina, he joined the staff of Michigan State University. Until 1968 he taught courses in agricultural policy and engaged in both research and extension work. Also, beginning in October, 1966, he served as director of the Kellogg Farmers Study Program in Michigan. This program was designed to provide broadening travel and study experiences for young rural leaders. He gave up this position in April, 1968, when he was appointed assistant dean and director of resident instruction at Michigan State.

Professor Feltner has done research in the general areas of marketing, econometric analysis of the U.S. agricultural economy, and farm organization structure and performance; and has published a number of articles and bulletins on these subjects.

Professor Feltner follows a line of distinguished heads of the Department of Agricultural Economics: Professor Halcrow (1947-1970), Garret L. Jordan (acting head, 1956-1957), Lawrence J. Norton (1955-1956), Harold C. M. Case (1934-1955), and Herbert W. Mumford (acting head, 1932-1934). From its founding in 1917 until 1932, the department was known as the Department of Farm Organization and Management. — *G. W. Salisbury*

COVER PICTURE supplied by the Illinois Department of Business and Economic Development.

No-Till Cropping Reduces Pollution

With the protective soil cover insured by no-till cropping, nutrient-laden soil particles stay on the fields instead of polluting our rivers and lakes

L. E. GARD

:s CONVENTIONAL TILLAGE in the long-range interest of this nation d its people? If not, what are the ernatives?

With the conventional tillage procdures now common in areas of intsified grain production, the soil lies protected from wind and rain tough much of the year. As rich sls are washed from our fields into r rivers and lakes, they are of no hefit either to us or to future nerations. Carrying with them a rden of nitrates, phosphates, pesties, and herbicides, they only add our growing pollution problem.

In recent decades, the problem of sion has been magnified as the w-moving horse has given way to dern tractors with excess power at ger-tip control. Thus, over-tillage easy and erosion may become astrophic.

By contrast with the soil-laden ter that flows from intensive grainducing areas where conventional age is practiced, the water flowing m forests and grassland is relaly clear and clean. Research has eatedly confirmed that surface lches of close-growing plants and p residues effectively reduce soil l water losses.

Research is further proving that in crops can be successfully grown planting them in crop residues h little or no tillage. The soil er is disturbed very little, and soil, er, and plant nutrients are conved. "No-till" cash grain producn is arousing the interest of

Equipment for collecting, measuring, and sampling runoff. A trough from the plot channels the runoff to a silt box (rectangular tank closest to the plot). Three hardware screens in this tank hold back debris as overflow water enters the multislot divisor. Water from the divisor's center slot flows into the round tank (water from the other four slots is discarded). Overflow water from this tank enters another multislot divisor; again most of the water is discarded as the rest flows into a second circular tank (not shown). Runoff is measured and sampled in all three tanks. (Fig. 1)

Gard is Associate Professor of Soil Conation, Department of Agronomy, Dixon ngs Agricultural Center.

agronomists and engineers and is gaining acceptance among many conservation-minded farmers.

According to results obtained both at the Dixon Springs Agricultural Research Center and elsewhere, no-till farming may provide a way of preserving our natural resources while we continue to produce the food and fiber needed by our population.

During the past 9 years corn has been produced on sod at the Dixon Springs Agricultural Center by no-till management with excellent results. More recently, during the past 5 years, corn following corn has been produced by the no-till method, with yields equal to those from conventional tillage. For the past 4 years, no-till double-cropping, combining wheat with corn and wheat with soybeans, has given very encouraging results.

Most recently, during the past 2 years, soil and water losses from no-till double-cropping have been compared with those from conventional tillage. The differences in favor of the no-till system have been phenomenal. The rest of this paper will be devoted to results obtained during the first year of this study.

Equipment and crops

The study is being conducted on nine plots, each 42 by 70 feet. The soil is Grantsburg silt loam. Six plots are on 9-percent slopes and three are on 5-percent slopes.

Each plot is surrounded by sheet metal walls. Runoff from a plot enters a metal collecting trough at the base of the plot. The trough is connected to a silt box-multislot divisor and tank unit for collecting, measuring, and sampling the runoff (Fig. 1).

Following soybean harvest in the fall of 1968, all nine plots were seeded to wheat. Three of the plots had conventional seedbeds; six, no-till seedbeds. On three of the no-till seedbeds, the wheat seeding was spaced to leave unseeded rows for interplanting corn ahead of wheat harvest.

Since the no-till spaced system has resulted in extremely low wheat yields and entails extremely difficult operational procedures, it does not appear practical. It is being replaced in the study and will not be further considered in this report, although results are included in the table on this page.

Water losses from one storm

According to past studies at Dixon Springs and at other research centers, 80 percent of the soil loss during a year or a crop production period is often due to one, two, or three rainstorms of either high intensity or extended duration (or both). The soil lost during major storms thus serves as a fair basis for estimating the conservation value of various management systems.

A rainstorm period of long duration and medium intensity occurred on January 26-31, 1969. Over 5¼ inches of rain fell during these 6 days, with 4¼ inches falling during one 27-hour period. However, rainfall intensity was not high for any 15-, 30-, or 60-minute period.

Water losses were relatively high on all plots. This was to be expected, since a fragipan soil like Grantsburg cannot absorb 4¼ inches of rain in 27 hours, if the soil is wet to start with.

During this specific storm, the no-till plots did not lose as much water as the conventional plots. However, water losses will not always be less on a no-till area. Right after a conventional seedbed is prepared, its uneven surface often provides temporary pondage pockets which exceed the pondage capacity on untilled soils. Thus, runoff from a conventional seedbed may at first be less than from a no-till seedbed. This situation is equalized or reversed after one or two rains, as the smoothing action of water seals the surface soil particles on an unprotected conventional seedbed, thus reducing water intake.

Other water loss factors

Conventionally tilled soils warm earlier in the spring than do no-till soils because of a higher evaporation rate. Thus, tilled soils favor early plant growth. The slow early growth of corn on no-till seedbeds may reduce yields in the northernmost areas adapted to corn, but not in the ma corn-production areas of Illinois.

As the season progresses, the hi evaporation losses from conventic ally prepared seedbeds become a c advantage in corn production. La of readily available soil moistu stresses the corn plant, reduci growth and grain development. D ing extended dry periods this pl nomenon appears sooner and is mo pronounced in plants on a conv tional seedbed than on a no- seedbed. Studies involving soil mo ture determinations confirm that c ventionally managed soils have l available moisture than those hand under a no-till system.

Soil losses from one storm

Soil losses from the conventio plots were extremely high during storm period of January 26-31, 19 These plots lost 16 times as much as the no-till plots on the 9-perc slope (8 tons as compared with ton); and 3 times as much on the percent slope (1½ tons as compa with ½ ton).

These differences were due marily to the soil surface cover

Yields and Soil and Water Losse From Double-Cropping on No-Ti and Conventional Seedbeds, 196

Tillage system	Wheat following beans[a] 9% slope	5% slope	Corn followin wheat[b] 9% slope
		Yield, bu./A.	
Conventional...	37	37	26
No-till........	32	28	45
No-till spaced & interplanted..	14	9	42
		Soil loss, lb./A.	
Conventional...	23,148	4,793	4,439
No-till........	2,368	1,641	80
No-till spaced & interplanted..	1,599	1,332	78
		Water loss, pct. rainf	
Conventional...	38.0	17.1	10.4
No-till........	38.0	26.9	16.7
No-till spaced & interplanted..	24.9	25.9	9.9

[a] From October 20, 1968 to June 20, 1969
[b] From July 23 to November 10, 1969.

ıe no-till plots. The crop residues rotected the soil particles from the nopping action of raindrop impact nd retarded surface flow (Fig. 2). ven though water losses are someımes less from freshly prepared conntional seedbeds than from no-till edbeds, soil losses have consistently een much higher from the convenonal seedbeds.

oil losses during ouble-cropping period

Soil losses for the double-cropping riod, October 28, 1968, to Novemr 10, 1969, were 10 times as great r conventional plots on the 9-pernt slope as for no-till plots (see ble). During the corn production ason (July, August, and Septemr, 1969), rainfall at Dixon Springs ıs 2.96 inches below normal and ere was no major rainstorm. Soil ses during this period were thus atively low under both systems of anagement. Even so, 50 times as ıch soil was lost from the convennal plots as from the no-till plots the 9-percent slope; and 6 times much on the 5-percent slope.

These differences assume major sigicance as one considers the anticited food and fiber needs 50 to 100 ars from now. Under conventional age, the entire plow layer of 6⅔ hes is destined to be eroded from 9-percent slope in 75 years, asning the rate of soil loss during s one cropping period.

heat yields

Vheat yields under both tillage tems were average for the season l soil type. The somewhat lower lds under the no-till system were tly due to the lack of a drill deıed for seeding small grains on a till seedbed. The no-till wheat l to be planted with the "Dixon rings" corn, sorghum, soybean nter. Many trips over an area required to simulate a grain drill ling with rows 7 or 8 inches apart. s planting method makes a unin spacing of wheat rows difficult, ot impossible, particularly on slopland. Upon broad acceptance of no-till system for wheat seeding, it appears logical that farm machinery manufacturers will design drills for this purpose.

Four days after the rainstorm of January 26-31, 1969, the conventionally tilled plot at left was so badly eroded that gullies were beginning to form. Erosion was prevented, however, by the dense protective cover on the no-till plot at right. (Fig. 2)

The overnight freezing and daytime thawing that cause heaving of the wheat plants, particularly on fragipan soils, is greatly reduced by the heavy mulch maintained in a notill double-cropping system. This is an important advantage.

Weeds, particularly grasses, were a major problem and had more influence on no-till wheat yields than on yields of the conventional system. Recent but limited work in the use of herbicides has resulted in partial control of some weed species. Additional investigation is needed.

Corn yields

Corn yields were extremely low on all plots. For good yields from lateplanted corn (late June and July), rainfall should be average or above and should be well distributed. As already mentioned, rainfall during the 1969 growing season was below the long-time average. Even though yields were low under both management systems, the no-till yields were nearly double those from the conventional plots.

The siltpan soils of the southern third of Illinois are drouthy, thus limiting the production of late-planted summer grain crops. As the need for increased production of food and fiber justifies the addition of irrigation systems, the effects of low rainfall on late-planted grain crops will be controlled, regardless of the seedbed system in use.

A reflection of change in agriculture

Farming, especially grain production, is in a state of flux. Labor costs, land prices, and marketing costs, along with many other factors, have brought increasingly large acreages under one man's management and labor. This has accelerated the ever-increasing search by farm operators to find new management systems. At the same time the public is becoming increasingly aware of the pollution induced by our present systems of land management.

Together, these trends obligate the agronomist and agricultural engineer to find systems that will maintain high yields, conserve our soil, and control pollution. No-till cropping may well be one of the most important tools that we have for reaching these goals.

PROTEIN NEEDS OF STEERS

Fed Various Combinations of Corn Silage and High-Moisture Corn

L. A. PETERSON, E. E. HATFIELD, and U. S. GARRIGUS

HIGH-ENERGY all-concentrate cattle diets are gaining popularity with cattle feeders for a number of reasons. Roughages are becoming relatively less economical. Cattle gain faster and more efficiently on an all-concentrate ration than on a ration that includes roughages. An all-concentrate ration reduces the amount of waste to be disposed of. And the trend toward mechanized feeding makes it easier to feed an all-concentrate ration.

If cattle are finished on an all-concentrate ration, how much protein do they need? An answer to this question was sought in a recent experiment in the Department of Animal Science.

Actually the experiment had a two-fold purpose: (1) to compare four levels of protein, and (2) to study the interaction of these protein levels with four levels of energy in the diet.

Plan of experiment

The experiment involved 160 Angus × Hereford steer calves of Montana origin. Corn silage, grass hay, and a small amount of a high-level antibiotic supplement were fed from the time the steers arrived until the start of the experiment on January 1, 1969. By that time they had regained their exact payweight.

Three weeks before the start of the experiment all steers were vaccinated against infectious bovine rhinotracheitis and parainfluenza-3. On January 22 the calves were implanted with 36 milligrams of diethylstilbestrol.

After being weighed on January 1, the calves were randomly assigned to 16 treatments, which consisted of four energy levels and four levels of crude protein. The energy levels were varied by using different combinations of corn silage and high-moisture shelled corn as follows:

	Energy level			
Ration ingredient	*A*	*B*	*C*	*D*
Corn silage, pct. air-dry[a]	100	67	33	0
High-moisture corn, pct. air-dry	0	33	67	100

[a] Air dry — 90 percent dry matter.

The four levels of crude protein were 9, 11, 13, and 15 percent. Each of the 16 treatments was designated by a number indicating the protein percentage and a letter indicating the energy level: 9A, 9B, 9C, 9D; 11A, 11B, 11C, 11D; 13A, 13B, 13C, 13D; 15A, 15B, 15C, 15D.

The different protein levels were obtained by formulating supplements with varying proportions of dry ground corn and a urea-soybean meal mixture. The urea (45 percent nitrogen) was mixed with the soybean meal (50 percent protein) at a ratio of 1 to 9 by weight.

All supplements contained additional minerals, vitamins, and antibiotics to meet the following minimum requirements of the total diet: 0.45 percent trace-mineralized salt, 0.25 percent calcium, 0.25 percent phosphorus, 0.5 percent potassium, 5 milligrams of chlorotetracycline, and 1,800 I.U. of vitamin A per pound of diet.

The supplements were fed in a ratio of 1 to 6 (air-dry basis) with the rest of the diet. All diets were fed twice daily to as near free-choice consumption as possible.

Dry-matter content of the corn silage was 35 percent and of the high-moisture shelled corn 74 percent. Tl high-moisture corn was stored oxygen-limiting type silos and roll before feeding.

Effects of protein and energy

As shown in Table 1, increasi the energy level of the diet increas average daily gains significantly. T greatest increase — 11 percent — r sulted when the energy level w raised from B (33 percent corn) C (67 percent corn). Increasing t protein level also increased avera daily gains.

A significant interaction of prote and energy was observed (Table 2 Increasing the protein levels had lit effect on daily gains of animals f rations A (all silage) and B (33 p cent corn). Increasing protein lev did, however, significantly increa the gain of animals on energy lev C and D.

Calves fed the all-concentrate di consumed significantly less feed (a dry basis) than steers fed varyi amounts of corn silage (Table Protein level, however, did not aff feed consumption.

As the energy level of the diet i creased, significantly less feed w required for 100 pounds of ga Increasing the protein level also i creased feed efficiency significan among cattle fed the two high energy levels. Cattle on the all-co centrate diets required the least fe per unit of gain when the prot level was 13 percent. Of the cattle o the C energy diet, those receiving 15 percent protein made the most ef cient gains. Increased protein did n improve feed efficiency among ca on the two lowest energy diets.

Cattle fed high protein levels re quired significantly less corn fo

L. A. Peterson is an Assistant in Animal Science; E. E. Hatfield, Professor of Animal Science; and U. S. Garrigus, Professor of Animal Science.

ound of gain than those fed low rotein diets (Table 1). The silage 'as about 50 percent grain on an ir-dry basis, and this corn was in- uded in the calculations. Cattle on ıe all-concentrate diet required less ›ncentrate than those receiving 33 ercent silage. Concentrate intake was mited on the two low-energy diets nature of the diets.

Carcass data from these cattle ere similar. No significant differ- ıces were observed in the amount of kidney, heart, and pelvic fat; carcass grade; marbling score; ribeye area; fat thickness; and USDA cutability grade. However, carcasses from steers on the higher energy diets dressed significantly higher and had a higher percentage of boneless trimmed retail cuts from the round, loin, rib, and chuck. Carcass gain followed the same pattern as average daily gains.

The number of abscessed livers (3.1 percent) was minimal, with no effect of dietary treatment being observed.

Table 1. — Mean Results According to Energy and Protein Levels

	Energy level[a]				Protein level[b]			
	A	B	C	D	9	11	13	15
. daily gain, lb.	2.60	2.75	3.06	3.26	2.77	2.89	2.91	3.10
ily diet, lb.	19.34	19.56	19.01	16.39	18.59	18.81	18.24	18.68
ed/gain ratio	7.41	7.09	6.17	5.05	6.62	6.41	6.17	5.95
ncentrate per 100 lb. gain, lb.	4.24	5.08	5.35	5.08	5.19	5.02	4.87	4.68

[a] Averages for all protein levels.
[b] Averages for all energy levels.

Costs and returns

The profitability of the different diets is shown in Table 3. Feed costs for 100 pounds of gain are for the duration of the experiment. Supplements were priced at $70, $80, $90, and $100 per ton for the four protein levels. Corn was valued at $1.40 a bushel. Corn silage was priced at $12.20 a ton, on the basis of 18 tons per acre of 35-percent dry-matter silage consisting of 50-percent corn on an air-dry basis. This value includes a charge of $2.50 a ton for additional harvesting and storage costs plus the cost of the corn in the silage.

The evidence obtained from this experiment, as well as from similar experiments at other stations, should help cattlemen select the protein level that, combined with the energy level fed, will give maximum returns.

Table 2. — Feedlot Performance of Steer Calves

	Treatment															
	9A	9B	9C	9D	11A	11B	11C	11D	13A	13B	13C	13D	15A	15B	15C	15D
ys on experiment	234.0	221.5	209.0	188.0	221.5	209.0	188.0	167.0	234.0	221.5	188.0	167.0	234.0	209.0	167.0	167.0
initial weight, lb.	449	460	477	462	468	477	486	473	487	472	464	456	470	469	472	476
final weight, lb.	1,054	1,049	1,083	1,014	1,053	1,069	1,042	996	1,076	1,058	1,035	1,026	1,100	1,074	1,027	1,060
daily gain, lb.	2.58	2.66	2.90	2.96	2.64	2.82	2.98	3.12	2.51	2.65	3.06	3.42	2.69	2.89	3.32	3.50
ly feed consumption, air-dry, lb.																
Corn silage	16.3	11.1	5.6	...	17.0	11.3	5.6	...	16.5	10.9	5.2	...	16.5	11.4	5.3	...
High-moisture corn	...	5.5	11.2	14.0	...	5.7	11.1	13.7	...	5.5	10.5	14.0	...	5.7	10.7	14.6
Supplement	2.7	2.8	2.8	2.3	2.8	2.8	2.8	2.3	2.7	2.7	2.6	2.3	2.7	2.8	2.7	2.4
otal	19.0	19.4	19.6	16.3	19.8	19.8	19.5	16.0	19.2	19.1	18.3	16.3	19.2	19.9	18.7	17.0
dry feed per 100 lb. of gain, lb.	7.35	7.30	6.76	5.52	7.52	7.04	6.54	5.13	7.63	7.19	5.99	4.76	7.14	6.89	5.62	4.85
centrate per 100 lb. of gain, lb.	4.21	5.21	5.79	5.52	4.28	5.04	5.62	5.13	4.38	5.16	5.17	4.76	4.09	4.90	4.82	4.85
of abscessed livers	0	1	0	0	1	1	0	0	0	0	0	0	0	1	0	1

Table 3. — Cost-Return Information for Steer Calves

	Treatment															
	9A	9B	9C	9D	11A	11B	11C	11D	13A	13B	13C	13D	15A	15B	15C	15D
	Dollars															
al value per ead[a]	150.64	154.33	160.03	155.00	157.01	160.03	163.05	158.69	163.39	158.36	155.67	152.99	157.68	157.35	158.36	1 59.70
d cost per 100 . of gain[b]	13.61	15.40	16.06	14.66	14.38	15.41	16.07	13.92	15.24	16.29	15.20	13.27	14.75	13.97	14.05	13.90
l feed cost	82.25	90.66	97.38	81.08	84.20	91.03	89.52	72.61	89.70	95.49	87.28	75.64	92.91	96.33	80.81	81.17
rhead at .10 er head per ay	23.40	22.15	20.90	18.80	22.15	20.90	18.80	16.70	23.40	22.15	18.80	16.70	23.40	20.90	16.70	16.70
l cost per 100 . of gain[c]	17.50	19.16	19.50	18.06	18.17	18.94	19.44	17.11	19.22	20.06	18.47	16.20	18.46	19.41	17.57	16.76
l carcass alue[d]	305.28	310.08	320.16	298.08	303.84	315.36	310.56	294.72	316.80	315.84	305.76	310.08	323.04	319.20	303.84	320.16
return per eer	48.99	42.94	41.85	43.20	40.48	43.40	39.19	46.72	40.31	39.84	44.01	64.75	49.05	44.62	47.97	62.59

[a] Initial cost, $33.55 per cwt.
[b] Feed cost for duration of experiment: corn = $1.40 per bu.; corn silage = $12.20 per ton; supplements = $70, $80, $90, $100 per ton.
[c] Includes feed cost of $.20 per head per day prior to start of experiment.
[d] Price based upon $48. per cwt. hot carcass weight.

Drying Shelled Corn With Electric Heat

A relatively small increase in temperature will dry corn satisfactorily within allowable storage period

GENE C. SHOVE

A NUMBER of Illinois grain producers are successfully drying shelled corn at low temperatures. Just enough electric heat is used to raise the air temperature a few degrees and lower the relative humidity.

For satisfactory results, maximum initial moisture content of the corn should be no greater than about 26 percent. Temperatures need to be in the range of 30° to 50° F. A 7-degree increase in air temperature has been found sufficient during most of the drying period.

Drying will be slow because low-temperature air can't absorb much moisture. However, corn can still be dried to 14 or 15 percent moisture content within 30 to 40 days. Thus, drying will be completed within the allowable storage time for high-moisture corn and before very cold weather. At extremely low temperatures, drying is very slow and electricity is used less efficiently.

Tables 1 and 2 present data collected from four farmers' bins in 1969. Grain was satisfactorily dried at all four locations. Drying was reasonably uniform throughout the bins. Judging from the limited amount of data in Table 1, 0.3 to 0.6 kilowatt-hour will be required to remove a percentage point of moisture from a bushel of corn.

Table 1. — Results of Low-Temperature Drying of Shelled Corn, 1969

	Bin A	Bin B	Bin C	Bin D
Location	Manteno	Monticello	Champaign	Monticello
Date of loading	Oct. 21-23	Nov. 1-4	Nov. 8-11	Nov. 25-26
Bushels of corn	8,000	11,796	7,142	3,100
Grain depth, ft.	14	13	14	15
Fan horsepower	7.5	7.5	15	3
Airflow, cfm/bu.	1	1	2	1
Fan energy, kwh total	3,960	4,500	11,500	2,016
Kwh/bu.	0.50	0.38	1.62	0.65
Heat energy, kwh total	15,840	12,000	16,788	4,435
Kwh/bu.	1.98	1.02	2.35	1.43
Temperature rise, °F.	12	7	7	6
Drying time, days	22	25	32	28
Initial moisture, pct.	19.4	19	24	18.5
Final average moisture, pct.	12.6	14.0	14.8	14.6
Kwh/bu. per percentage point of moisture removed	0.37	0.28	0.44	0.54

Airflow and fan horsepower

Airflow needs to be from 1 to 2 cfm per bushel, depending on the moisture content of the corn. An airflow of ½ cfm per bushel will not dry the corn before cold weather (ILLINOIS RESEARCH, 12:3). The following minimum rates of airflow are based on investigations during the 1969 harvest season:

Initial corn moisture content	*Minimum airflow*
22 pct.	1 cfm/bu.
24 pct.	1½ cfm/bu.
26 pct.	2 cfm/bu.

Guidelines for selecting fan horsepower to provide an airflow of about 1 cfm per bushel are given in Table 3. For this airflow, grain depth should not exceed about 20 feet to keep horsepower requirements within reasonable limits.

For a greater airflow, it is more practical and economical to redu[illegible] grain depth than to increase fa[illegible] horsepower. For example, if 7[illegible] horsepower delivers 1 cfm per bush[illegible] through 8,000 bushels at a depth [illegible] 18 feet (Table 3), the same hor[illegible]power will deliver at least 2 cf[illegible] per bushel through 4,000 bushels [illegible] a depth of 9 feet. Airflow can [illegible] increased beyond 1 cfm per bush[illegible] by proportionately decreasing th[illegible] amount and depth of grain given [illegible] Table 2 for a given fan horsepow[illegible].

New storage should be as shall[illegible] as possible.

Table 2. — Moisture Content at Different Grain Levels After Low-Temperature Drying, 1969

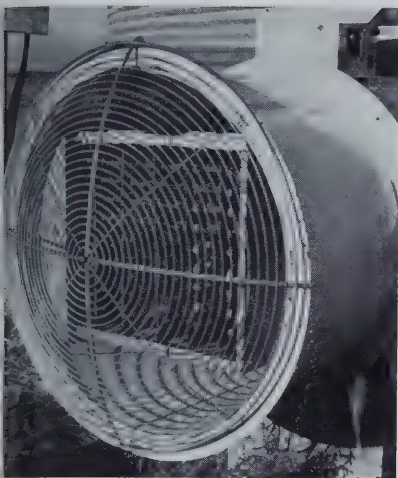
Corn level, ft.	Percent moisture content: Bin A	Bin B	Bin C	Bin D
15	..	..	..	15.[illegible]
14	14.5	..	..	15.[illegible]
13	13.3	..	..	14.[illegible]
12	13.1	16.4	17.7	14.[illegible]
11	12.7	15.8	16.4	14.[illegible]
10	12.5	15.0	15.8	14.[illegible]
9	12.5	14.6	14.9	14.[illegible]
8	12.6	14.6	14.7	14.[illegible]
7	12.5	14.0	14.3	14.[illegible]
6	12.3	13.4	14.4	14.[illegible]
5	12.1	13.4	14.3	14.[illegible]
4	12.3	13.0	14.1	14.[illegible]
3	12.1	13.4	14.1	13.[illegible]
2	12.4	13.0	14.0	14.[illegible]
1	12.1	13.0	14.0	14.[illegible]
Floor	11.8	12.8	14.1	13.[illegible]
average	12.6	14.0	14.8	14.[illegible]

Sizing the heater

The kilowatts of electric resista[illegible] heat required to raise the tempe[illegible]ture of a volume of air can be c[illegible]culated from:

$$kw = \frac{cfm \times \text{temperature rise}}{3,000}$$

Gene C. Shove is Associate Professor of A[illegible]cultural Engineering.



he heater may be installed at the air let side of the fan.

able 3. — *Guidelines for Selecting Fan Horsepower to Provide Airflow of About 1 cfm per Bushel*

Bin ameter, ft.	Grain depth, ft.	Level fill, bu.	Static pressure, in. of water	Fan hp.
18........	16	3,300	2.0	3.0
22........	20	6,000	3.0	5.0
27........	18	8,000	2.5	7.5
27........	22	10,000	3.5	10.0
34........	18	13,000	2.5	10.0
36........	13	10,000	1.0	7.5
36........	18	15,000	2.5	15.0
40........	20	20,000	3.0	20.0

According to this equation, 1 kilo-att of electric heat will raise the mperature of 1,000 cfm of air 3 grees. It is therefore suggested that kilowatts, in three stages, be in-illed for each 1,000 cfm to provide mperature rises of 3, 6, or 9 degrees. ie heat from an air-over fan motor ll raise the temperature about 2 ore degrees, permitting temperature es of 2, 5, 8, or 11 degrees.

For example, a system designed for ,000 cfm will require a 30-kilowatt ater that can be operated as a 10- 20-kilowatt heater as well as at kilowatts. When drying weather favorable, only one or two stages the heater will need to be oper-ed. Unfavorable weather may call the operation of all three stages.

Electric heaters for low-tempera-e grain drying should be operated continuously. This prevents the cycling of the electric load that may occur if a humidistat or thermostat control is used.

Installing the heater

Electrical resistance strip heaters designed for placement in air ducts are available in a variety of configurations and kilowatt ratings.

However, the heater doesn't have to be installed in the air duct. Instead, it can be installed as a free-standing, portable unit at the air inlet side of the fan. It can then be easily moved and used at other locations or stored when not in use. The small temperature rise from the heater will not affect the operation of the fan motor.

For portable installation, a strip heater can be mounted in a protective open-ended enclosure or short section of duct, following the same specifications as for mounting in an air duct.

Two important precautions are necessary when installing an electric heater: (1) Safety shielding and grounding of the heater must be adequate. (2) The heater control voltage should come from the fan motor circuit so that the heater cannot be energized unless the fan is in operation. Only heaters equipped with high-temperature-limit switches should be purchased, but these devices should not replace the requirement of obtaining the control voltage from the fan motor circuit.

An indicator light in the heater circuit is a helpful addition. It will enable you to see quickly whether the heater is energized. If the heater is subjected to the proper airflow either in the duct or at the inlet side of the fan, the heater elements will not glow red. If portions of the elements do glow, perhaps some adjustment in the placement of the heater can be made. This is not absolutely necessary, since electrical resistance heat elements are designed to withstand temperatures which cause them to glow. However, for even heating of the air, the heater elements should be uniformly distributed in the air stream.

An alternative method of checking the operation of a heater is to mount the outdoor sensing bulb of an indoor-outdoor thermometer downstream from the heater or in the plenum under the perforated floor. The indoor bulb should be kept in the shade, preferably in the unheated air stream, or the small temperature difference may not be detected. Do not wholly depend on the temperature difference shown on the thermometer to indicate the actual temperature rise unless you make other checks to test the accuracy of the thermometer readings.

Power supply

The kilowatt demand for electric heat grain drying can be sizable and may require some changes in your electrical system. The first step in planning the installation is a discussion with your power supplier. Even if no changes are needed in your system, the supplier should be informed of the extra load.

Loading the bin

Proper airflow and distribution of corn are extremely important in low-temperature drying. Completely perforated floors are most conducive to good airflow. The corn should be screened as it goes into storage and a grain distributor should be used to avoid pockets of fines and trash.

The bin can be loaded without delay up to the quantity of corn allowable in view of moisture content and proper airflow. However, since airflow is always greater than the selected flow until the maximum permissible grain depth is reached, the corn will dry faster if loading is not completed all at once.

Risks should be understood

Despite the success obtained with low-temperature drying, it can be a risky proposition. The wetter the corn, the greater the risk. Any system for drying at low temperatures should therefore be based on a thorough understanding of the relationship between air temperature, grain moisture content, and allowable storage time.

House Roof Frame Designed With Space for Storage

DONALD H. PERCIVAL

When houses had attics, it was no problem to store old family momentoes, broken furniture awaiting repair, past issues of the *National Geographic*, and all the other items that a family accumulates through the years.

However, with the advent of the low-sloped prefabricated roof-truss and its various interior parts crossing back and forth, attic storage has become nonexistent or, at best, severely limited. And most recent house designs have not included any other area to be used for storage.

Now, with changes in style, we have come full circle and are again seeing houses with steeper roofs than those popular in the late 1940's and the 1950's. Since we are always look-

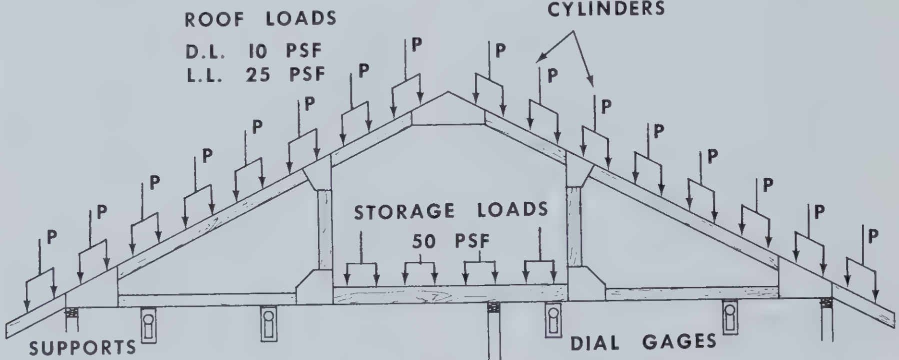
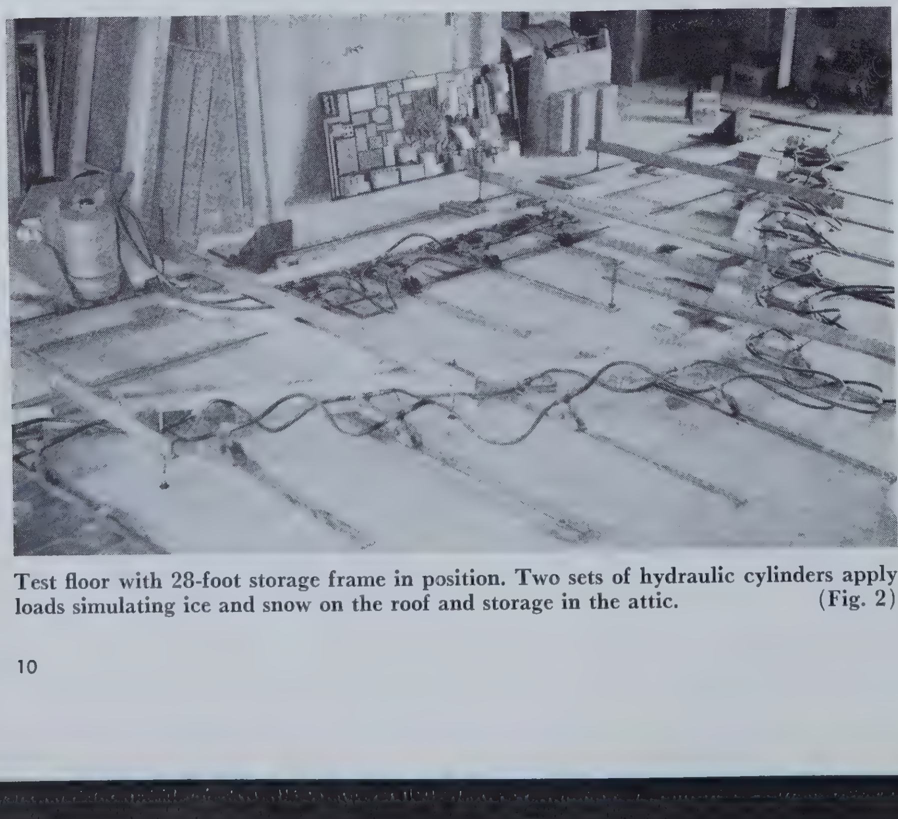


Diagram of a frame in a typical set-up with cylinders applying roof loads ("P") and storage loads. A dead load of 10 pounds and a live load of 25 pounds per square foot are used for the roof; a live load of 50 pounds per square foot, for the storage area. Dial gages measure deflection of frame when loads are applied. (Fig. 1)



Test floor with 28-foot storage frame in position. Two sets of hydraulic cylinders apply loads simulating ice and snow on the roof and storage in the attic. (Fig. 2)

ing for storage space, our attentio has again been turned to the att space possible in homes with th steeper roofs. However, even with th increased roof slope, the roof-truss ha become an economical and common accepted construction technique an its interior structural members kee us from using the attic to any grea extent for storage.

To get around this problem, th Small Homes Council–Building R search Council undertook to design roof-truss that would incorporate storage area. A frame was develope to support attic storage as well as th structural part of the roof.

The usual procedure in such study was followed. That is, structur frames were first designed on the ba of theoretical analysis. Then full-sca units were built and tested to dete mine structural capabilities.

In designing the frames, a com puter analysis method developed Professor S. K. Suddarth of Purd University was used to calculate th stresses of the frame and to determi lumber sizes and other engineeri information. Two rafter-frames we designed, each essentially a modifi truss. One had a 26-foot span w a 6/12 roof slope. The other had 28-foot span with a 5/12 slope.

Each design required a load-be ing wall, or bearing partition, to h support the frames when they w installed in a house. The partiti could be located at any position long as it was within 2½ feet of center line of the house.

Three full-scale frames of each sign were constructed of kiln-dr southern yellow pine lumber. T top chords, or roof members, lower outside members, and the ve cal posts were all 2x6's. The cen member for supporting the stor was a 2x8. Chords were connec with nail-glued plywood plates each junction.

All six frames were tested by st dard methods to determine whet they had the deflection charac

Donald H. Percival is Research Associate fessor of Wood Technology and Utiliza Department of Forestry and Small H Council–Building Research Council.

Vood Scientists Make Boards From lant Residues

S. WALTERS

THE VOLUME of plant-fiber residues · developed from farming, lumber-g, and milling operations in Illinois ıst be tremendous. In the past the idues were burned, dumped, or left til they decayed. Some were ap-ed to the soil, but the percentage ed in this way was only a fraction the total volume produced.

Anti-pollution legislation has cre-ed a new interest in finding uses for residues. Burning them pollutes air; dumping them into water-ys is no longer an acceptable means disposal. A pile of sawdust, corn-s, or sawmill slabs is unsightly and occupies space. In addition to these idues, there is a large volume of od in trees that has neither a pretty in nor a desirable color, and some es are too small or of too poor ality to be usable at present.

The Department of Forestry is dying ways of converting wood idues and substandard wood into ble products, thereby solving the posal problem and at the same e developing a new source of ome for the producers.

n exploratory tests, panel boards good strength were made from dust, corncobs, cornstalks, corn leaves, tree bark, wood chips, and mixtures of these residues. The test panels were too small for results to be conclusive, however, so a larger hot-press has recently been obtained for the study.

A variety of materials, including hardwood shavings, oak bark, walnut bark, hickory sawdust, cornstalks, and corncobs, were used to make these wood panel boards. (Dark rectangles in background are shadows, not panels.)

Various fiber residues will be mixed with glue and the mixture pressed into a sheet with the hot-press. The press will both compact the particles and cure the adhesive. Some boards will be light in weight for insulating walls and ceilings; others will be dense and strong for wall sheathing, cabinet parts, and table tops.

Bending strength, stiffness, water-absorption capacity, swelling, and screw-holding ability of the panels will be measured. Different kinds and amounts of adhesive will be correlated with the stiffness and bending strength of the panel boards.

An attempt will be made to use the best properties of each material. For example, the way the fibers are oriented in a plant such as a cornstalk may give superior strength if the same orientation is used in a panel.

One of the objectives of the study will be to make the panel boards fire- and decay-resistant by treating them with chemicals.

C. S. Walters is Professor of Wood Technology and Utilization, Department of Forestry.

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es and structural capabilities speci- by building codes and lending ncies. The trusses have to be stiff ugh to prevent plaster and dry-l finish materials from cracking, strong enough to support various s of loads, such as snow on the and stored items in the attic.

he frames were loaded on a hy-ılic test floor at the Small Homes ıncil. Simulated roof loads were lied along the top chords of the frame through one set of hydraulic cylinders and the storage loads applied to the 8-foot central area with a second set of cylinders (Figs. 1 and 2).

Results of the actual full-scale tests were compared to the theoretical or computer analyses. Very close similarity was found in the deflection characteristics. Deflection of all frames was well within the limitations as required by the building codes.

After the deflection readings were taken, each frame was loaded until it failed. No failure occurred until the load was more than 2½ times as great as the design load specified by most building codes and lending agencies.

Both storage frame designs and additional information are available from the Small Homes Council–Building Research Council, University of Illinois, 1 East St. Mary's Road, Champaign, Illinois 61820.

Nitrifying Microbes Play Important Role in Plant Nutrition

Nitrifying bacteria and fungi convert every form of soil nitrogen to nitrate, the form most easily available to plants

PAUL D. SHAW

NITROGEN is something we can't live without. It is part of many important constituents of living cells, and is essential to all forms of plant and animal life. In actual mass, however, it represents only about 0.5 percent of living matter.

A very versatile element, nitrogen occurs in many different forms in nature. One of the most common forms is nitrogen gas, which makes up about 78 percent of the air we breathe. Another common form is nitrate, which is found in large deposits in Canada and Chile.

Nitrogen is also found in the form of ammonia, although the ammonia is often combined with carbon, hydrogen, and sometimes other elements to form organic nitrogen compounds. Almost all nitrogen compounds found in living things are of this last type. Examples are proteins, several of the vitamins, the nitrogen compounds in genes, and the nitrogen compounds found in the membranes and walls of cells.

The biological processes by which plants and animals make, use, and ultimately destroy nitrogen compounds are very complex and as yet are not completely understood. One important part of the biological interconversion of nitrogen compounds is called nitrification. This is the process by which ammonia is transformed into nitrates or other compounds which contain nitrogen combined with oxygen.

Nitrification is accomplished by two kinds of microorganisms. One type is a special group of bacteria, and ammonia is their starting material. The other type of nitrification is carried out by certain fungi which form nitrate from organic nitrogen compounds.

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Both types have been known for a number of years, but bacterial nitrification has been the more thoroughly studied. Only since 1961 has it been recognized that the mechanism by which fungi nitrify ammonia might be different from the one used by bacteria. In terms of the total amount of nitrogen transformed in the soil, bacteria are thought to be more important than fungi. However, there appear to be few studies on the relative amounts of bacterial and fungal nitrification.

Nitrification by bacteria

Nitrifying bacteria are found in the soil and in the oceans. Soil bacteria have been studied more extensively than ocean bacteria, but when comparisons have been made, the two types of bacteria appear to carry out nitrification in essentially the same way.

In soil, two organisms are responsible for most of the bacterial nitrification. One is the genus *Nitrosomonas* and the other is called *Nitrobacter*. These two organisms work together to transform ammonia into nitrate in four steps. In the first three steps, *Nitrosomonas* organisms convert ammonia to nitrite. *Nitrobacter* organisms then take over and change nitrite to nitrate in one step. The overall nitrification process can thus be described by the following equation:

ammonia $\rightarrow \rightarrow \rightarrow$ nitrite $\rightarrow$ nitrate

The details of how the bacteria convert ammonia to nitrite and then to nitrate are not completely und stood; however, the function of t process for the bacteria is known. mentioned previously, all living thi require nitrogen for the synthesis essential compounds. The nitrify bacteria are unusual in that they a use nitrogen compounds as a sou of energy. *Nitrosomonas* burns a monia and *Nitrobacter* burns nit much as plants and animals use su to provide energy for growth, rep duction, and other functions. *Nit somonas* cannot grow without a monia and *Nitrobacter* cannot gr without nitrate.

Nitrification by fungi

Fungi appear to nitrify ammo by a process quite different from t used by bacteria. So far two gen of fungi have been studied — *As gillus* by Professor Alexander at C nell and *Penicillium* in this lab tory. There may also be other fu capable of carrying out nitrificat

Neither *Aspergillus* nor *Penicill* can transform ammonia to nit directly. Rather, they require that ammonia first be built into an org compound called aspartic acid. T compound is one of the 19 am acids which are found in prot Our *Penicillium* can make asp acid from sugars and ammonia.

The nitrogen of aspartic acid essentially the same form as amm so the next step must be to con the nitrogen into an organic c pound containing nitrogen equiv to nitrite or nitrate. The mecha by which this is accomplished is known, but the product of the t formation is called β-nitroprop acid. This compound contains trogen in the same form as ni

Nitropropionic acid is then decomsed to nitrate.

Unlike the bacteria, fungi derive obvious advantages from nitrifiion. They can be grown in the oratory under conditions where niication does not occur. Apparently y get the energy they need from er sources, presumably by the oxiion of sugars. It is possible that y can also obtain some energy m the nitrification process, but this ot known.

ole for nitrification agriculture

The nitrogen requirements of liv- things are quite diverse. Animals, example, have very strict rerements. The nitrogen in their ts comes almost exclusively from protein of plants or from other mals.

Higher plants, with a few exceps, have much less exacting rerements. Usually simple, inorganic pounds such as nitrate or amnia will satisfy their needs. This holds true for most microorgas. Some organisms, the "nitrogenng" bacteria, can even live on the ogen in the air. A simplified pic- of the interconversions of nitrogus materials in nature is shown the following diagram.

At one time, the limiting factor in these processes was the rate at which atmospheric nitrogen was fixed by microorganisms. About 48 million tons of nitrogen a year was added to the soil in this way. More recently the use of chemical fertilizers such as nitrate and ammonia has added another 33 million tons of usable nitrogen each year. This nitrogen is used by higher plants, which are in turn used as food by animals.

The nitrogenous materials in animal waste products and in dead and decaying plants and animals are broken down to ammonia by microorganisms. Nitrifying organisms may then act upon the ammonia and the resulting nitrate may be reused by plants or changed to nitrogen gas by the denitrifying microorganisms. This nitrogen gas may then be returned to the atmosphere.

It would appear that no matter what form of nitrogen is introduced into the soil, it is ultimately converted to nitrate by the nitrifying microorganisms. This may be a very rapid process. Ammonia, for example, is completely nitrified in one to seven days, depending on the conditions.

This would seem to be a great disadvantage to the growth of plants, since nearly all the nitrogenous materials of plants are organic ammonia compounds. To utilize nitrate, plants must first convert it back to ammonia, and this process requires energy.

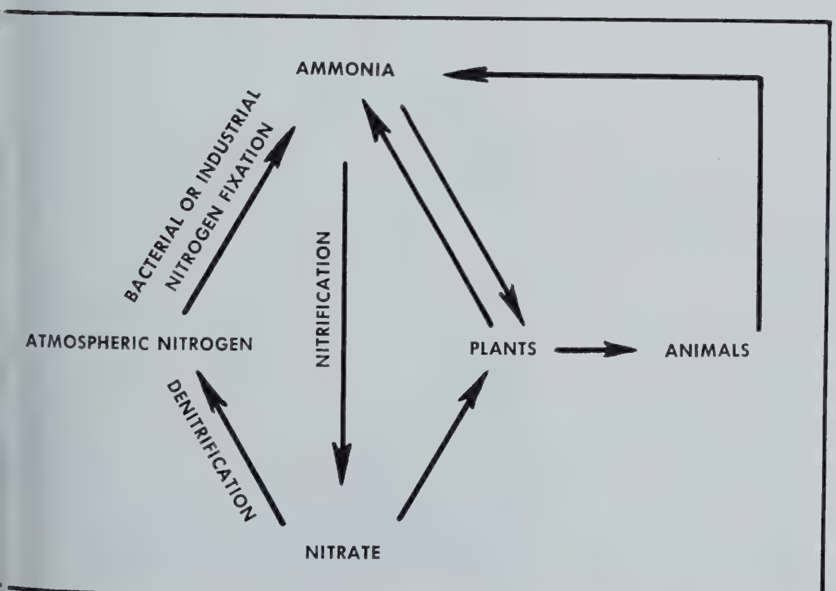
Actually, however, nitrate is a better nitrogen source for plants than ammonia for several reasons. Ammonia is adsorbed to materials such as clay so that it cannot move freely in the soil. It is thus not readily available as a plant nutrient. Nitrate is not adsorbed, so it can move in the soil and is readily available. In addition, under most conditions of temperature, light, and humidity, plants grow better with nitrate as a nitrogen source. The reasons for this are not completely understood although it is known that ammonia can be poisonous if plants absorb too much of it.

It has also been found that when certain forms of ammonia are used as plant nutrients, the absorption of ammonia by the plants causes changes in the amount of acid in the soil. As a result, the soil becomes either too acid or too alkaline for good plant growth.

Microbial nitrification is thus very important in providing the best nitrogen compound for plant growth. Unfortunately nitrification may also create some problems. The very property that makes nitrate desirable as a plant nutrient — its ability to move in the soil — also allows it to be lost from the soil easily.

When ammonia is applied infrequently in large amounts instead of being released slowly but continuously by nitrogen-fixing bacteria, much of the nitrate produced by nitrification may be dissolved by water in the soil and then lost by run-off. This dissolved nitrate would not only be unavailable to the plants for which it was intended, but it would become a potential source of pollution in streams, lakes, and even water supplies used by animals and human beings for drinking. This could become a serious problem because nitrate is poisonous to most animals if they consume too much of it.

A better understanding of nitrification and possibly studies on its control would seem to be very important in alleviating these potential or perhaps existing problems.



conversions of nitrogeneous materials in nature.

Germfree Swine Valuable Tools for Studying DIARRHEA IN BABY PIGS

R. C. MEYER

More than 20 germfree litters have been used to study the effects of the bacterium Escherichia coli

DIARRHEA in baby pigs may have many causes — both physiological and microbial. For this reason, the disease is not always easy to prevent or cure. When the cause is microbial, however, research with germfree pigs is adding a great deal to our knowledge of this malady.

The concept of germfree animals is not new — it goes back more than 70 years. Only within the past decade, however, have these animals been produced on a widespread scale. By now, several species of germfree animals are proving to be useful tools in a diversity of biological studies.

A germfree animal is a special kind of gnotobiotic animal. The term gnotobiotic stems from the Greek words *gnos* (known) and *bios* (life). A gnotobiotic animal thus is one which has been reared in a controlled environment and can be characterized as to the other life forms, if any, that exist in, on, or in association with it. The term "germfree" is applicable only when accepted procedures have failed to detect microorganisms in or on the animal.

The production of gnotobiotic animals is not simply a procedure for rasing healthy conventional animals, but is the creation of a unique life form. It is possible because the fetus in a healthy pregnant animal is well protected from the external environment and is generally germfree. If the offspring are removed by aseptic surgical procedures, they can then be introduced into a sterile chamber and reared on a sterile diet in an environment free of all microbes.

R. C. Meyer is Associate Professor of Veterinary Pathology and Hygiene and of Microbiology.

Value and production of germfree swine

In recent years considerable emphasis has been placed on the production of germfree swine. These animals have obvious advantages in the study of swine diseases such as diarrhea. They are more uniform in susceptibility than conventional pigs. And, of course, the microbial environment can be controlled and manipulated. With the germfree pig, it is possible not only to identify pathogenic organisms accurately, but also to explore the interaction of selected bacteria, viruses, and diet in the cause of a specific disease.

The value of germfree swine does not stop with research specifically related to swine, but extends to studies with broad biological implications for other species, including man. A major advantage of using swine in biological studies is their advanced development at birth. Their eyes are open, they can walk almost immediately, and they can feed themselves within hours of delivery.

There are other advantages as well: The large litter sizes provide animals of similar genetic background for experimental and control groups. The gestation period is uniform enough to permit surgical delivery with a high yield of live animals. And the pig resembles man in the anatomy and physiology of the skin, vascular system, eye, and gastrointestinal tract; and in its omnivorous eating habits.

Germfree swine can be obtained by two surgical techniques — the hysterectomy and the hysterotomy. Both require special equipment and have inherent advantages and disadvantages.

In the hysterectomy the pregn sow or gilt, just before normal p turition (usually the 112th day gestation), is suspended by her r legs and anesthetized. The gra uterus is removed and passed int sterile chamber (hysterectomy ho through a trap containing a ger cidal solution (Fig. 1).

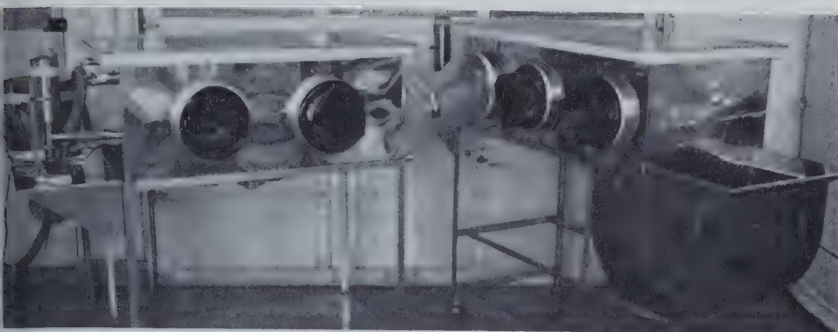
Once inside the sterile cham the uterus is opened and the pig are removed and passed into an tached transfer unit. There they washed in antiseptic, their umbil cords are cut and tied, and they dried with soft sterile towels. sterile transfer unit is then sealed disconnected and the piglets are tr ferred to special rearing units ca isolators (Fig. 2). These consis sterile or microbially controlled ch bers where the pigs can be rea without contamination with extr ous agents in the environment.

A hysterectomy is essentially same as a human Caesarean sec It is more difficult and time-cons ing than the hysterectomy. Howe it has the advantage that the sow be saved. When valuable bree stock is involved, the hysterotomy be the procedure to choose.

Work with E. coli

The College of Veterinary M cine, University of Illinois, has o the few facilities in the countr rearing gnotobiotic swine for s disease studies. To date 32 l have been obtained by the hyst tomy technique. Of these, 27 l have been germfree.

Most of the germfree litters been used to study the micr



terectomy hood at far right with attached transfer unit at near right. Large tub-like nsion in front of hood is trap for the germicidal solution through which the uterus assed before being put into the hood. (Fig. 1)

ses of diarrhea in baby pigs — ticularly the role of *Escherichia*

.

s early as 1899, Jensen isolated *coli* and other microbes from pigs 1 diarrhea. However, the isolation microbe from a diseased animal is proof that the organism is the se of the disease. For proof, the ase has to be reproduced in a thy animal.

'hrough the years many investi- ors have tried to reproduce en- is in baby pigs experimentally 1 different isolates of *E. coli* and r agents such as *Vibrio*. Their rts met with varying success. At- pts to produce diarrhea in con- ional animals are complicated by umber of factors. These include the effect of age on susceptibility and clinical course of the infection, presence or absence of specific colostral antibody, and the interactions of other microbes which may be present in the intestinal tract.

Only in the past few years have investigators both here and elsewhere succeeded in reproducing enteric diseases in baby pigs by the use of *E. coli*. The first successes were obtained with conventional and colostrum-deprived pigs. More recently, the disease has been reproduced in newborn gnotobiotic swine.

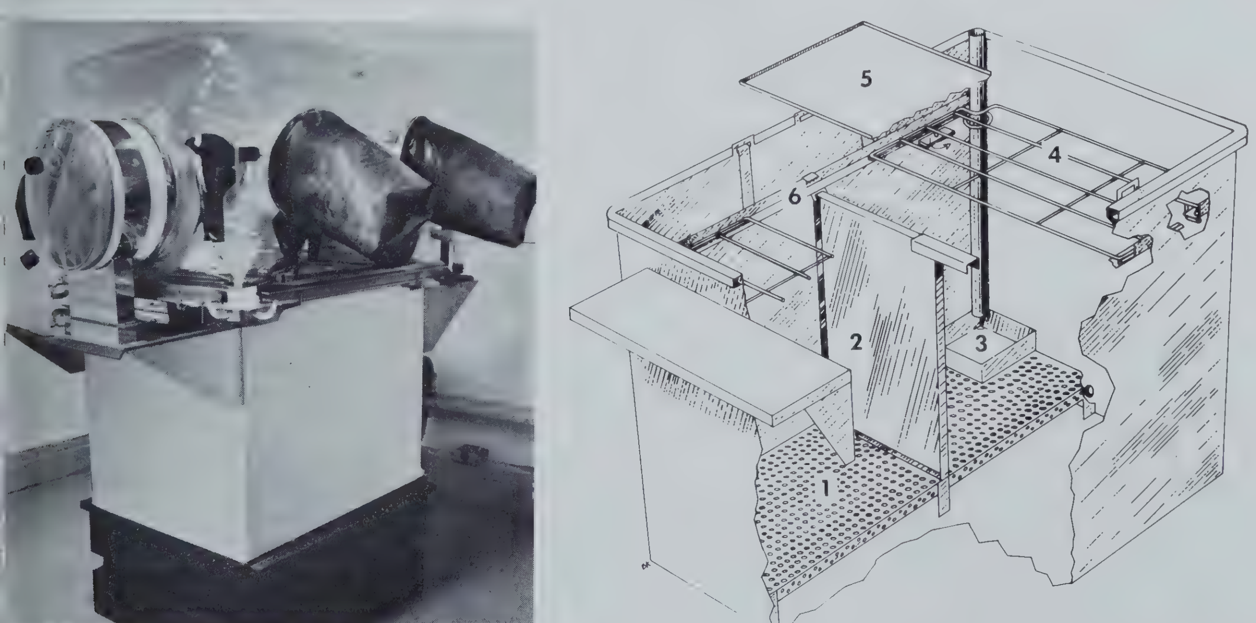
Recent estimates by Stevens in Great Britain emphasize the importance of *E. coli* as a cause of diarrhea. He believes that only 25 percent of diarrheal diseases in pigs are due to specific causes other than *E. coli*. These include *Clostridium, Salmonella, Vibrio,* TGE virus, toxic substances such as arsenic, and various nutritional disorders. Most of the remaining cases, he believes, are associated with *E. coli* in some way. His estimates are difficult to verify, but are worthy of consideration when establishing research priorities.

Significant findings

These are some of the significant findings thus far:

- Disease is caused by only a relatively few of the total number of strains of *E. coli* that exist in nature. The O grouping of *E. coli,* for example, is not proof of pathogenicity.
- Depending on the strain of *E. coli* involved, more than one clinical form or type of disease can occur.
- The source of *E. coli* pathogenic for swine is not limited to other swine but can come from a variety of other species such as cats, dogs, and even the producer himself.

The findings thus far confirm the value of gnotobiotic swine as a research tool. Although the use of germfree pigs is demanding and time-consuming, it provides the most sensitive and uniform test system available for the study of enteric swine diseases.



Tub isolator for rearing germfree swine, with cut-away diagram showing internal removable parts: (1) false flooring, (2) partition, (3) feeder, (4) retaining grid, (5) shelf, and (6) retainer bar. (Fig. 2)

MORE FOREIGN MARKETS

Are Needed for the Products Of U.S. Farms and Factories

S. C. SCHMIDT

TODAY the United States can look back on 20 years of balance-of-payment deficits in its international economic transactions. Before 1958, the deficit helped to correct the world shortage of gold and currency reserves. It also contributed to economic expansion here and abroad. Since 1958, however, the deficit has served no useful function.

The balance-of-payments concept resembles a double-entry accounting system. Each international transaction has a counterpart on the credit and on the debit side of the balance-of-payment account. On the expenditures side we have (1) payments for merchandise imports; (2) private investments; (3) services from foreigners, such as tourist accommodations, and gifts to foreigners; (4) military assistance; (5) private remittances, pensions, and property income; and (6) U.S. government economic grants and loans. Items on the receipts side are categorized in the same way.

Since the early 1960's, each administration has sought to ameliorate the balance-of-payment problem by promoting exports and reducing overseas purchases by U.S. government agencies. Efforts were also made to maintain stable domestic prices and thus prevent a relative loss in the international competitive position of American goods. After 1963 policy focused on private capital movement. A tax to equalize interest was enacted to restrain long-term borrowing in the United States. Unfortunately, these efforts were largely nullified by escalation of the Vietnam War, which increased military expenditures and exerted a heavy strain on the U.S. balance of payments.

S. C. Schmidt is Professor of Agricultural Marketing and Policy.

Trends for major components of balance of payments

On merchandise accounts the United States, until the middle 1960's, sold substantially more merchandise abroad than it bought. In 1960-1964, the surplus of exports over imports averaged $5.4 billion a year. By 1969, however, it had dropped to only $0.7 billion.

This decline is due to a combination of internal and external factors. One internal factor is the loss of stability in the U.S. cost-price structure. Another is the demand for imports associated with the rapid rise in domestic output.

The major external factors are the development and growth of regional trading blocs such as the EEC and EFTA, nontariff barriers, undervaluation of foreign currencies, and the Vietnam War. These factors caused U.S. imports to grow much faster than exports (111 percent vs. 68 percent) in the 1960's.

Since total U.S. exports have also lagged behind those of major foreign competitors — especially Germany, Japan, and Italy — the country's share of world exports fell to just over 18 percent in 1969. The average share in 1960-1964 had been about 19.5 percent.

While the merchandise trade surplus diminished, net income from direct foreign investment and other assets rose, reaching $4.8 billion in 1968 and $4.5 billion in 1969. On the other hand, interest payments on foreign investments in the United States increased also, reflecting heavy U.S. short-term borrowing at high interest rates.

There appears to be a growing deficit in the balance on military goods and services transactions. As usual, there was an increase in travel expenditures. The outflow U.S. private capital for direct vestment abroad continued to r reaching $4.1 billion in 1969.

ILLINOIS TOP EXPORTER OF AGRICULTURAL PRODUCTS

Illinois has a big stake in the futur of U.S. trade. It ranks first amon the states in the value of its agri culture exports, accounting fo almost 10 percent of the nationa total. In fiscal 1970 it furnishe about 23 percent of the fee grains exported, as well as 2 percent of the protein meal, 2 percent of the soybeans, an 19 percent of the soybean oil.

In value of total exports, Illinoi now ranks second. Its chief manu factured export is nonelectrica machinery, particularly constru tion and agricultural machinery.

Agriculture's contribution

Agricultural commodities are counting for a decreasing percent of total U.S. exports. Averaging percent of total exports in the 196 they declined to 16 percent in 19 Agricultural exports totaled ab $5.9 billion in 1969, 5 percent than in 1968.

Exports are a significant source income for the U.S. farmer, wh recent years has obtained about seventh of his income from the of products abroad. In 1969 the port market accounted for two-fi of the U.S. production of soybe cattle hides, and tallow; and for m than one-third of our wheat and f seed production.

Of the $5.9 billion exports, billion were noncommercial, or s ments made under various gov ment-financed programs. The maining $4.9 billion, represen commercial agricultural exports, in exact balance with U.S. agri tural imports for consumption.

;3-1968, however, commercial agri-
tural exports were greater than icultural imports, thus contrib-
ıg positively to the U.S. balance of ments. This contribution reached ıigh of \$2.4 billion in 1964, but been declining ever since, par-
ılarly since 1966.

ɔan as a market

apan is the leading dollar market U.S. farm products, followed by ıada, the Netherlands, West Ger-
ny, and the United Kingdom. In 9, shipments to Japan totaled 4 million, which was slightly ve the 1968 level. Feed grains tinued to be the principal export Japan, reaching a value of \$278 lion. This was 32 percent of U.S. l grain exports that year. Japan provided the largest foreign out-
for wheat and oil seeds.

apan is a potential market for ı-quality beef. At present only the ted States produces enough of ı beef to meet Japan's needs. vever, Japan limits imports to)00 tons. This is due to two rea-
;: a desire to expand Japan's beef ıstry and the availability of ample k supplies.

uture feed grain requirements in an will depend largely on that ıtry's trade, investment, price, and stock production policies. For ex-
ıle, chickens require less feed n per unit of dressed meat than ;. Milk requires less feed grain energy unit of consumer product ı any other livestock product. It ıld be remembered, also, that ın has a rather limited option for ınded beef production, as land carce and expensive. Although ın's needs for feed grains during 1970's may vary widely, a gen-
ıy upward trend can be expected.

le policy issues

he importance of governmental :ies in determining our future gn trade is of course not limited Japan. Throughout the world, rnments have committed them-
s to providing farm people with g standards similar to those of strial workers. This objective is being pursued through a variety of price support, income support, and resource use programs. These programs, in turn, have led to governmental intervention in foreign trade and price formation.

Inevitably government restraints on trade and domestic policies of price and income support become one system. Programs that keep agricultural prices above world market levels can be maintaned only by restricting entry of competitive products through quotas or by using tariffs, levies, or other means to eliminate price differentials. In any event, it is the consumer who pays.

Possible courses of action

In view of the importance of the export market, the United States needs to foster a liberal trade policy that will lead to expansion rather than contraction of agricultural trade. Trade offers long-range benefits to all parties concerned, and may even be necessary, for at least four reasons.

1. The ability of foreign customers to buy American goods depends on their ability to sell and thereby earn the needed resources.

2. Trade enables countries to specialize in the goods that they can produce most efficiently. Such specialization and competition will mean a reduction in costs that can be passed on to consumers. Import competition also discourages domestic price increases and expands the range of available products. By providing an anti-inflationary safety valve, imports help maximize the real incomes of consumers.

3. Expanded trade, particularly exports, will help improve the balance-of-payments problem.

4. The United States can most effectively exercise its world leadership by increasing economic ties with other countries and thereby contributing to economic growth and world peace.

Although tariff and nontariff barriers to trade in industrial goods have been reduced, they remain extensive enough to keep efficient agricultural producers from selling competitively in world markets. More seriously, little reduction has been made in nontariff barriers to trade in agricultural products. These nontariff barriers — the major tools of agricultural protectionism — range from conditional imports and quotas to embargos. Nontariff barriers impede trade more seriously than tariffs. Tariffs may be offset by an increase in efficiency leading to lower costs and prices, but most nontariff barriers cannot be surmounted at all.

Some countries use these devices to regulate foreign exchange payments because of balance-of-payment problems. Many more retain nontariff barriers to protect their domestic agricultural production.

The visible barriers then serve mainly as palliatives against maladjustments in the economies of the nations applying these barriers. Only by alleviating the underlying causes of protectionism will it be possible to remove trade restrictions. And this in turn depends on bringing the domestic farm programs of major trading countries into line with world market conditions.

Willingness on the part of major trading partners to bargain with each other on domestic farm policies and to assume reciprocal commitments would represent a significant departure from previous trade negotiations. Notwithstanding the apparent difficulties, it seems imperative to step up the search for new negotiating tools and for the formulation of trade policy objectives and positions. The establishment of a new agency — an International Coarse Grain Council — might help to achieve some of these goals.

Such a council is envisaged as a companion agency to the International Wheat Council. Basically, a coarse grain council could serve as a forum for inter-governmental discussions on all aspects of trade, including conditions of access and prices. The sole aim should be to maintain a favorable development of trade. This task would involve a continuing review of major developments in national agricultural price stabilization and support policies and evaluation of trends in the production and utilization of grains.

Frozen Precooked Chinese Entrées: Thiamine Content and Palatability

JOYCE C. SO, AIKO K. PERRY, and FRANCES O. VAN DUYNE

An increasing interest in foreign foods is reflected in the appearance of precooked, frozen Chinese entrées on the market.

Because of this interest, it was decided to investigate the effects of freezing, freezer storage, and reheating on the thiamine content and palatability of three Chinese dishes. Previous research on other precooked combination dishes indicates that freezer storage and reheating may cause undesirable changes in appearance, color, texture, and flavor. However, no controlled experiments on precooked frozen Chinese foods have been reported.

A precooked meat (Shanghai-style pork chops), a rice dish (ham fried rice), and a combination meat and vegetable dish (sautéed beef with celery) were selected for study. Each product was prepared four times in sufficient quantities for evaluation when freshly prepared and after 2 and 4 months of freezer storage.

For the Shanghai-style pork chops, boneless butterfly pork chops were marinated in a sauce containing salt, sugar, monosodium glutamate, cornstarch, pepper, soy sauce, and cooking sherry. They were then fried in soybean oil in a deep-fat fryer.

The recipe used for the preparation of ham fried rice included soybean oil, beaten egg, green onions, cooked converted rice, soy sauce, sugar, monosodium glutamate, and diced cooked ham.

To prepare the sautéed beef with celery, frozen flank steak was cut into strips, marinated in soy sauce and cornstarch, sautéed in soybean oil, and added to pieces of celery seasoned with monosodium glutamate and sautéed in oil.

Before freezing, precooked chops were sealed in packages of heavy aluminum foil. Samples of ham fried rice and of beef sautéed with celery were packed in aluminum freezer containers.

Five members of the food research staff rated the freshly prepared and reheated frozen samples on appearance, color, texture, and flavor. A 5-point scale was used with 5 corresponding to very good; 4, good; 3, fair; 2, poor and 1, very poor. Total scores were obtained by adding those for the individual palatability factors. Moisture, crude fat, and thiamine determinations were made on samples of raw and freshly prepared products and on products that had been frozen, stored, and reheated.

When freshly prepared, the three products had total mean scores ranging from 18.4 to 18.8, out of a possible 20 (Table 1). These scores correspond to mean ratings of high good.

Table 1. — Mean Palatability Scores for Chinese Entrées

Products and treatments	No. of ratings	Mean scores: Appearance	Color	Texture	Flavor	Mean total scores
Shanghai-style pork chops, freshly cooked	20	4.5	4.8	4.6	4.9	18.8
Cooked, frozen, stored 2 mo., reheated	20	3.6	4.1	3.5	3.8	15.0
Cooked, frozen, stored 4 mo., reheated	20	3.5	3.9	2.9	3.5	13.8
Ham fried rice, freshly cooked	19	4.4	4.6	4.8	4.9	18.7
Cooked, frozen, stored 2 mo., reheated	20	4.1	4.0	4.0	4.2	16.3
Cooked, frozen, stored 4 mo., reheated	20	3.9	3.8	3.9	4.0	15.6
Sautéed beef with celery, freshly cooked	19	4.0	4.8	4.8	4.8	18.4
Cooked, frozen, stored 2 mo., reheated	19	2.9	2.9	3.3	3.7	12.8
Cooked, frozen, stored 4 mo., reheated	20	2.5	2.5	2.9	3.0	10.9

Table 2. — Moisture, Fat, and Thiamine Content of Freshly Cooked Entrées

Product	Moisture, pct.	Crude fat, pct.	Thi- min mcg.
Shanghai-style pork chops	56.2	10.5	12.8
Ham fried rice	62.1	7.8	2.1
Sautéed beef with celery	68.9	9.9	0.[illegible]

After 2 months of freezer stor and reheating, ham fried rice w rated good in every characteris After 4 months it was rated betw high fair and good. However, free storage and reheating markedly creased the quality of precooked p chops and sautéed beef with cel Deterioration increased with len of storage period, particularly in sautéed beef with celery.

The reheated sautéed beef iridescent, slightly dry, and tou the celery slightly limp and da and the sauce watery. The pork ch became drier, tougher, and a li darker, and developed a slight flavor.

In Table 2 are given mean va for the moisture, crude fat, and t mine contents of the freshly prepa products. Shanghai-style pork ch had a lower moisture content a freezer storage and reheating, stantiating the comments of the t panel. While a significant amour thiamine was lost during precoo there was no significant loss (or as determined basis) during fre storage and reheating. Nor was t a loss of fat.

The moisture, fat, and thiar contents of ham fried rice were changed significantly by freezer age and reheating. Sautéed beef celery lost small amounts of fat thiamine during these treatments

Of the three products studied, fried rice is the only one that ca recommended as a satisfactory bination dish for freezing.

Joyce C. So is a former graduate studen partment of Home Economics; Aiko K. is Instructor in Foods; and Frances O. Duyne is Professor of Foods. This art based on Mrs. So's Master's thesis.

Homemakers and Consumer Credit

CAROLE L. HOLLENBECK and MARILYN M. DUNSING

MORE THAN HALF of the nation's families use some form of con- ımer credit each year, whether to ıy durable goods, to meet unex- ected expenses, to pay living ex- enses when incomes are interrupted, · to finance the family between pay- ıys.

How often and how wisely do ımemakers use consumer credit? ow much do they know about the fferent types of credit? How do ey prefer to pay for their pur- ıases? To find some answers to ese questions, and also to suggest ides for future studies, a pilot study ıs recently conducted in the De- rtment of Home Economics.

For this study, 50 families were ected by a stratified, random npling technique. They lived in a ıampaign subdivision in houses iginally priced from $12,000 to 8,000. Information was collected ım the homemakers by the inter- w-questionnaire method, with the erview being conducted by one of authors.

The 50 homemakers averaged 35 ırs of age and had been married average of 13.2 years. The number children living at home averaged t to 2.7 per family. The homemak- had an average of 11.5 years of ooling, with 60 percent having had ır years of high school; 26 percent, er years of schooling; and 14 per- ıt, schooling beyond high school.

Of the husbands, 29 were in blue lar occupations; 21, in white col- occupations. The median income the families was between $7,000 l $8,000.

edit use

More than half (54 percent) of the ilies used 30-day charge accounts. those using charge accounts, the rage number of accounts was 3.7 and the average amount spent per month was $23. Revolving charge accounts were used by 48 percent of the families, with the average user having 1.5 accounts and spending $18 per month. Most of the 30-day accounts were with department stores and gasoline stations, while most of the revolving accounts were with department stores.

During the 18 months preceding the interview, 46 percent of the families had used the installment plan. The average size of installment payments in the month before the interview was $46.

Credit knowledge

The women were asked to respond "true," "false," or "undecided" to a series of statements about 30-day accounts, revolving accounts, and installment buying. As shown by the following tabulation of average responses, the women knew considerably more about 30-day accounts than about the other two types of credit:

	Percent of responses		
Type of account	*Correct*	*Undecided*	*Incorrect*
30-day charge	70	19	11
Installment plan	52	37	11
Revolving charge	47	41	12

At least 90 percent of the homemakers knew that paying 30-day charge accounts when they are due helps establish a good credit rating, and that a store has a legal right to refuse any applicant for a 30-day charge account. On the other hand, only about 25 percent of the homemakers knew that young people 15 to 18 years of age are not permitted to open their own charge accounts at every Champaign-Urbana store. Also, only about 25 percent knew that stores do not necessarily set a maximum amount that a person can charge on a 30-day account.

About three-fourths of the homemakers recognized that as the amount of a downpayment is increased, the amount of money paid in interest will decrease. However, only 16 percent recognized that the service charge for revolving charge accounts is generally 1½ percent per month on the unpaid balance.

Feelings about payment methods

The homemakers were asked to choose one or more methods of payment that they considered most appropriate for eight different types of merchandise. They were given a choice of four methods: cash, 30-day charge account, revolving charge account, and installment plan.

All but one of the women considered that the only desirable method of buying food was to pay cash. For liquor, 74 percent considered cash the only desirable method; the other 26 percent believed that liquor should not be purchased. In addition, a majority of the women thought that cash payment was the preferable way of buying three other types of merchandise: gasoline (82 percent), recreational equipment (82 percent), and clothing (70 percent).

The installment plan was considered the most desirable method of buying automobiles (indicated by 98 percent of the women), home appliances (68 percent), and home furnishings (64 percent).

Additional studies desirable

Further studies with more homemakers would be desirable to determine the effect of selected family characteristics on the homemaker's knowledge of and attitudes toward consumer credit. The husband's knowledge and attitudes should also be investigated. Such studies would give professional workers in areas such as extension, adult education, and social work some of the information that they need to help families improve their economic welfare.

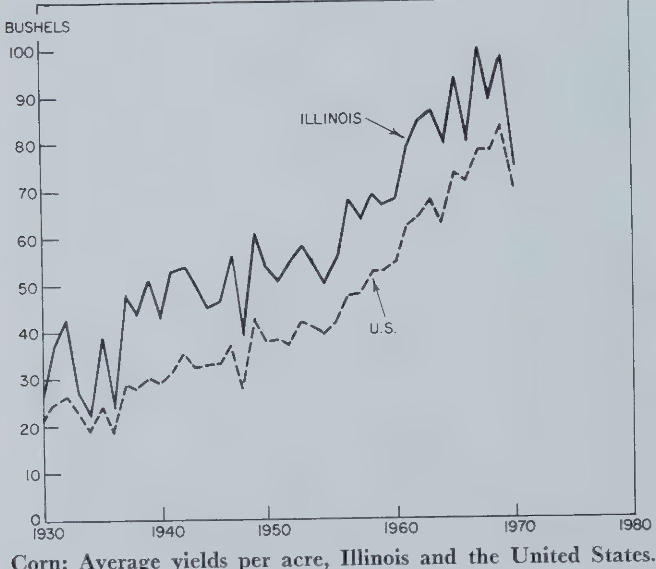
ole L. Hollenbeck is a graduate student, artment of Home Economics; Marilyn M. sing is Professor of Family Economics.

FARM BUSINESS TRENDS

THE PAST YEAR — 1970 — will long be remembered as the year, or more probably as the first year, of the disastrous corn blight. A new and deadly form of the southern corn leaf blight appeared first in the southern states, where it destroyed many fields. Before the year was over, it infected most of the corn in the eastern half of the nation, inflicting severe damage in the southern part of the Corn Belt.

The amount of damage done by the blight cannot be accurately estimated, for most areas that had heavy infestations of blight also suffered from other unfavorable conditions. These included too much rain at planting time, severe drouth during the main growing season, high temperatures during pollination, and extensive attacks by various insect pests.

The national average yield per acre dropped from the record 84 bushels in 1969 to 72 bushels, the lowest since 1964 (see chart). The greatest percentage yield



Corn: Average yields per acre, Illinois and the United States.

reductions were in the southern states, where the dis ease attacked the corn before the grain was formed ir many fields. State averages there were reduced 40 t 50 percent from normal levels. Among Corn Belt state the greatest yield loss was in Illinois, where the stat average was cut about 25 percent; and in Indiana where the yield was down about 20 percent.

The western edge of the Corn Belt suffered muc more from severe drouth than from blight. Yield slumped to the lowest levels in several years in Sout Dakota, Nebraska, and Kansas, and were poor in th western sections of Iowa and Missouri. The state ave age yield for Iowa was down about 5 bushels fror normal.

The northern edge of the Corn Belt had good yield with Minnesota and Michigan reaching new all-tim highs. Wisconsin had an average yield, despite seve drouth over a large area.

Prospects for this year are very uncertain. The 197 crop apparently could be anywhere from three-fift of a crop to a record-breaker. On the favorable side (1) Seed will be better, because the most susceptib varieties will be discarded and the remaining suppli will be shifted around to make better use of resista varieties. (2) Farmers in the eastern Corn Belt pro ably will get their crop off to a better start than 1970. (3) The western edge of the Corn Belt like won't suffer so much from drouth. (4) Weather co ditions could be less favorable for the blight. The b danger is that a large number of blight spores w overwinter in the Corn Belt and thus get an early st on their destructive mission.

Seed companies are planning to greatly increase th production of seed of resistant varieties this year. Hen corn production should get back to normal in 1972.— *L. H. Simerl, Professor of Agricultural Economics*

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Spring, 1971

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

This hundred-year-old stand of sassafras has provided enjoyment for generations of Douglas County residents (page 12).

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE Volume 13, Number 2

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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DO YOU HAVE ANY QUESTIONS ABOUT RESEARCH OF THE AGRICULTURAL EXPERIMENT STATION?

THE Illinois Agricultural Experiment Station has over 400 ac research projects. Only a few can be reported in any one issu ILLINOIS RESEARCH, and these cannot always be reported c pletely. So perhaps you have some questions about topics that h not been covered in recent years, or that have been covered briefly.

Have you heard or read about a research project that you w like to know more about? Or are you wondering whether rese is being conducted in a particular area? Do you have quest about an article that has appeared in this magazine?

Whatever your question, please send it to the editor of ILLI RESEARCH, 123 Mumford Hall, Urbana, Illinois 61801. We refer questions to the appropriate specialists for answering, and try to print as many questions and answers as possible in fu issues.

We cannot, of course, guarantee to publish all the questions we receive. In particular, we cannot publish those that ask general information not related to research. Since ILLINOIS RE-SEARCH is dedicated to disseminating the results of Experiment tion research, we can use only questions and answers that will us keep our readers informed about the multifaceted work o Station.

For years, beef cattle have done well on sorghum grain silage at the Dixon Springs Agricultural Center. Sorghum grain silage has also proved a satisfactory substitute for corn silage in sheep rations.

orghums Replace Corn in ilage for Beef Cattle

. CMARIK and G. E. McKIBBEN

YBRID GRAIN sorghum silage is an excellent substitute for corn sil- at any time, but particularly :n corn is heavily infected with : T of southern corn leaf blight. orghum silage gave good results eeding trials at the Dixon Springs icultural Center from 1958 to 8. In addition to the feeding ls, variety trials have been con- lted for a number of years to select best adapted sorghum hybrids.

ld and quality of silage

'he special advantage of hybrid hums in a year of corn blight is trated in Table 1, which shows ls of three sorghum varieties and corn varieties in 1970. The sor- ms yielded more silage than the ı, and two of the sorghum varie- yielded more 12-percent grain ı the SX 7 corn variety. Even n corn is not blighted, yields from id grain sorghums have been parable to those from corn.

high-quality whole plant silage usually be composed of about 50 ent grain and 50 percent stover. sorghum varieties in Table 1 all t this criterion.

Cmarik is Assistant Professor of Animal ce; G. E. McKibben is Associate Professor ronomy.

A further indication of a high-quality silage is that 7 pounds of the silage will contain the equivalent of 1 pound of grain with a 12-percent moisture content. One can select hybrid corn and grain sorghum varieties that will approximately meet this test, as shown by the figures below. These figures indicate the pounds of silage (30) percent dry matter) that will contain 1 pound of 12-percent grain.

Variety	*Lb.*	*Variety*	*Lb.*
NK 270	9.32	SX 7	6.52
NK 280	7.29	SX 52	6.37
NK 300	7.96		

Even though corn silage yields were greatly reduced by blight, the quality of the silage (as measured by the grain component) was not greatly impaired

Some feeders have wondered whether they need to feed special supplements with sorghum silage. However, when grain sorghum is fertilized in the same manner as corn — which it should be — the protein content of the grain and stover will be similar to that of corn (Table 2). Thus, the same kinds and amounts of supplement would be fed with sorghum silage as with corn silage.

Performance of animals

Generally sorghum silage will produce gains in live weight similar to those from corn silage.

In the 1964-65 trial summarized in Table 3, the sorghum silage was higher yielding — both in total tons and in percent of grain — than the corn silage. Although calves made somewhat greater gains on the sorghum silage than on the corn silage, it took slightly more total dry matter to produce these gains.

In 1963-64, when the silage and grain yields of sorghum and corn were more comparable, the average

Table 1. — Yields of Hybrid Grain Sorghum and Corn, and Plant Component Parts (Planted June 22, 1970, in 30-Inch Rows)

Variety	Yield per acre		Component parts, dry matter basis			
	Grain, 12% moisture	Silage, 30% dry matter	Grain	Brush	Stover: Stalk	Stover: Leaf and sheath
	100 lb.	*tons*	*percent*			
Sorghums						
NK 270	36.4	17.0	47.6	3.7	16.1	32.7
NK 280	61.7	22.5	51.9	3.6	22.1	32.4
NK 300	56.8	22.6	45.0	2.1	28.6	24.3
Corn						
SX 7[a]	44.8	14.6	45.8	...[c]	16.3	18.1
SX 52[b]	9.1	2.9	8.7	...[d]	41.3	32.2

[a] Blended corn hybrid infested with blight (T portion 50 percent).
[b] T hybrid corn heavily infested with blight.
[c] Cob, 12.5 percent; husk and shank, 7.3 percent.
[d] Cob, 5.7 percent; husk and shank, 12.1 percent.

Table 2. — Protein in Component Parts of Corn and Hybrid Grain Sorghum, 1970[a]

Variety	Av. protein, dry matter basis		
	Grain	Leaf and sheath	Stalk
	pct.	*pct.*	*pct.*
SX 7 (corn)	12.34[b]	7.71	4.99
NK 270	15.05	6.48	5.43
NK 280	13.74	7.01	3.33
NK 300	11.82	6.37	2.80
PAG 515	13.39	5.78	4.21
Asgrow Double TX	12.60	5.08	3.24

[a] 150 pounds of nitrogen applied July 23.
[b] Probably higher than if it had not been blighted. (Where measured in a 50-percent blend, blighted corn had 12.43 percent and unblighted corn, 9.98 percent, on a dry matter basis.)

Table 3. — Effects of Sorghum and Corn Silages on Weight Gains of Wintered Beef Calves, 1964-65

	Sorghum silage	Corn silage
	lb.	*lb.*
Aver. daily gain	1.71	1.66
Daily feed per head		
Silage	32.00	24.30
Stover portion, D.M.	3.78	4.18
Grain portion, D.M.	5.37	4.05
Soybean meal, D.M.	1.50	1.50
Total dry matter	10.56	9.73
D.M. per lb. of gain	6.23	5.86

daily gain from sorghum silage was 1.54 pounds and from corn silage, 1.58 pounds. As in 1964-65, the sorghum silage was less efficiently used than the corn silage.

Can efficiency be increased?

Feed trials in 1966-67 were aimed at determining whether feed value could be improved by feeding sorghum grain separately from stover silage. The trials involved seven lots of eight weanling bull calves each. One lot was fed stover silage only. Five lots were fed stover silage plus either whole high-moisture grain, whole dry grain, or ground dry grain. The seventh lot was fed whole plant silage without any additional grain. The calves were on test 65 days.

Whole high-moisture grain, whether fed separately or as part of whole plant silage, was utilized more efficiently than whole dry grain (Table 4). But grinding the dry grain greatly increased its value. The total dry matter required for a pound of gain was 25 percent less for ground dry grain than for whole dry grain fed at the same rate.

Table 4. — Performance of Beef Calves Fed Whole Plant Sorghum Silage or Stover Silage Supplemented with Sorghum Grain, 1966-67[a]

Lot	Silage[b]	Grain[c]	Grain D.M., pct. of live wt.	Aver. daily gain, lb.	Lb. D.M. per lb of gain	
					Grain	Stove
1	Stover	. . .	0	.19	. . .	24.17
2	Stover	Whole high-moisture	0.82	1.46	2.78	3.07
3	Stover	Whole dry	0.89	1.40	3.15	3.5
4	Stover	Ground dry	0.89	1.82	2.39	2.6
5	Stover	Whole high-moisture	1.31	2.05	3.30	2.3
6	Stover	Whole dry	1.42	1.82	3.91	2.4
7	Whole plant		(1.03)[d]	2.51	4.61	

[a] All calves received 1.5 pounds of soybean meal daily.
[b] Stover silage, 18.49 percent dry matter; whole plant silage, 32.30 percent dry matter.
[c] High-moisture sorghum grain, 62.11 percent dry matter; dry sorghum grain, 90 percent dry matter.
[d] If 50 percent of total dry matter is grain.

With the good results from whole high-moisture grain and from ground dry grain in 1966-67, it was decided to try grinding high-moisture grain for the 1967-68 feeding trials. These trials involved four lots of weaned calves, with nine steers and nine bulls in each lot. The calves were on test 51 days.

All calves received sorghum stover silage. The silage was supplemented with (1) ground high-moisture ear corn, (2) ground dry sorghum grain, (3) whole high-moisture sorghum grain, and (4) ground high-moisture sorghum grain.

Grinding the high-moisture sorghum grain did improve efficiency (Table 5). With ground high-moisture grain, 20 percent less dry matter was required to produce a unit of animal gain than with ground dry sorghum; 15 percent less than with whole high-moisture sorghum; and 6 percent less than with ground hi moisture ear corn.

Recommendations

With planning, hybrid grain s ghums can be harvested in two se rate components — grain and sto Grain sorghum plants maintain th juiciness as a standing crop ove long period.

The stover can be ensiled and grain made into sorghum-head sil or stored as high-moisture grain as dried grain. Various combinati of grain and stover can be used wintering, growing, and finishing l cattle.

Since the preceding data indi a definite advantage for high-m ture sorghum grain, producer-fee should consider high-moisture s age. However, if grain is to be d for storage, recommendations equipment manufacturers should followed carefully. Grain sorgh dries more slowly than corn of c parable moisture content, and loading depths should usually more shallow.

Table 5. — Performance of Beef Calves Fed Sorghum Stover Silage Plus Dry Ground Grain or High-Moisture Whole or Ground Grain, 1967-68[a]

Grain supplement	Grain D.M., pct. of live wt.	Aver. daily gain, lb.	Lb. D.M. per lb. of	
			Grain	Sto
Ear corn, high-moisture ground	1.29	2.34	3.03[b]	1.
Sorghum, dry ground	1.37	2.16	3.54	1.
Sorghum, high-moisture whole	1.37	2.19	3.32	1.
Sorghum, high-moisture ground	1.31	2.54	2.85	1.

[a] All calves received 1.5 pounds of soybean meal daily. Sorghum stover silage contained percent dry matter; high-moisture sorghum grain, 58.22 percent; high-moisture snapped corn, 39.67 pe dry sorghum grain, 90 percent.
[b] Includes cob and husk.

›outhern Corn Leaf Blight)evelopment to Be Monitored

E. BURNS and M. C. SHURTLEFF

NOBODY can predict with any certainty the extent and severity of ıthern corn leaf blight in 1971. ıly a few plant diseases can be fore- .t months in advance, and at pres- : leaf blight is *not* one of them.

However, plant pathologists and natologists are making a big effort study the epidemiology of southern n leaf blight wherever corn will grown this year. They will follow ease development, gather informa- ı on the factors that affect it, and ke short-time forecasts to assist wers.

:tors affecting disease spread

outhern corn leaf blight is caused the fungus *Helminthosporium ydis* and is spread by asexual res, or conidia (Fig. 1). The co- .a of *H. maydis* are produced on ıased corn tissue during warm (60° 30° F.), humid weather. They can blown an estimated 200 miles or e over land without losing their ility. Splashing rain droplets also dge the spores and carry them lants in the field.

he 1971 Illinois corn crop may be cked by conidia blown in from southern corn-producing states, vell as by those produced from wintering sources in Illinois. The ibution and development of the ise will be largely determined by weather conditions and the sus- ibility of the corn varieties that grown.

forecasting projects

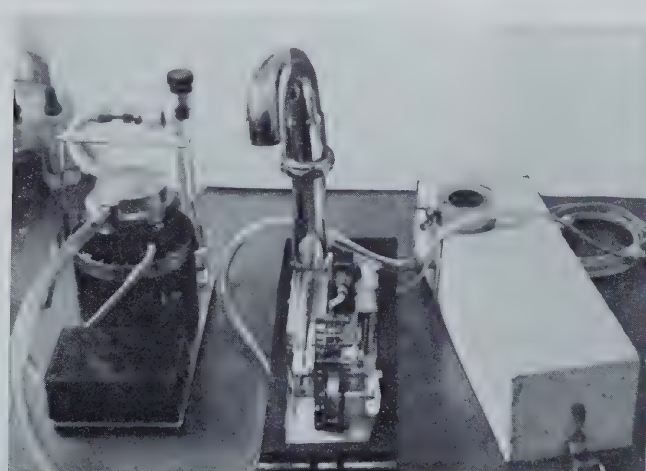
inois plant pathologists are co- ating in two major projects for asting the potential epidemic uthern corn leaf blight. One is the Dixie Early Warning (DEW line) Service, which was set up by Extension pathologists in the southern states. They will make a county-by-county survey of the disease and keep more northerly regions updated. In return, northern plant pathologists will provide information on resistance, overwintering, and chemical control.

The second project is a network of spore traps in corn-growing states to monitor the spread of *H. maydis.* This is a cooperative project of the colleges of agriculture and the U.S. Department of Agriculture. Dr. Jack Wallin at Ames, Iowa, will coordinate and release all the spore trap data. Whenever possible, these data will be accompanied by local weather records — rainfall, temperature, relative humidity, dew, and wind velocity. Nearly every college of agriculture in the corn-growing states is studying the overwintering of *H. maydis,* and this information will be compiled also.

Two spore traps (Fig. 2) are located in Illinois — at Dixon Springs and at Urbana-Champaign. A vacuum pump draws spores from the air into the trap. The spores adhere to a glass slide, the upper surface of which is coated with silicone grease. A clock mechanism advances the slide once every hour, and the slide is changed every day. When placed on the stage of a microscope, the slide can be examined for the characteristic spores of *H. maydis.* They are about the same size as ragweed pollen grains.

By monitoring the spores of *H. maydis* in the air, we can (1) detect buildups of spore populations and predict possible "spore showers"; (2) provide information to farmers and chemical applicators who may want to protect corn plants with fungicides; and (3) possibly enable growers to make decisions related to the problem of southern corn leaf blight — such as whether to grow alternate crops, when to plant, and when to harvest.

Conidia of *Helminthosporium maydis,* magnified about 100 times. The round cell indicated by the arrow is a chlamydospore. It is thicker walled than other cells and may be the mechanism that enables the organism to overwinter. (Fig. 1)



Vacuum pump and spore trap. Cover is removed from trap to show clock mechanism and slide track. (Fig. 2)

Burns is Instructor and M. C. Shurtleff, sor, both in Plant Pathology.

Heat Units Used in Field Corn Production

C. Y. ARNOLD

PRODUCERS of an increasing number of crops are depending on heat units — particularly degree days — for some of the information they need.

Since the 1940's, degree days have been used to time successive plantings and predict harvest dates for highly perishable crops such as sweet corn and peas. More recently they have been adopted by producers of less perishable crops, such as lima and snap beans, spinach, and tomatoes, as the once-over mechanical harvest makes planting and harvest dates more crucial.

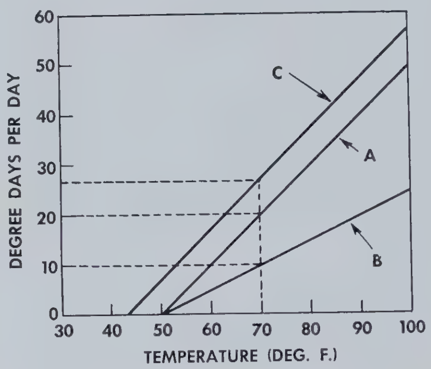
Now producers of even less perishable crops, such as field corn and soybeans, are using degree days, rather than days, to compare the length of the growing season with the time that a variety requires to mature. To achieve this aim, the field corn interests have adopted a different method of calculating heat units than that used in the vegetable industry.

Function and principles

As used in crop production, a heat unit system attempts to account for variations in the time required for a plant to go from one stage of development to another. The system is based on some relationship between temperature and the rate of plant development.

Degree days per day is a rate figure in the same category as miles per hour. The degree day value assigned to a variety in a seed catalog is the summation of estimated daily rates between planting and harvest. A particular degree day value will reflect the temperature-rate relationship used in the calculations. The three linear temperature-rate systems in Figure 1 illustrate the effects of altering this relationship.

C. Y. Arnold is Professor of Vegetable Crops, Department of Horticulture.



Temperature-rate curves vary with base temperature and rate of increase. (Fig. 1)

In *system A* (Fig. 1) the zero rate (base temperature) is set at 50°F. Above 50° the rate is assumed to increase by 1 degree day per day for each increase of 1°. The slope of the temperature-rate line is 1.

In *system B* the zero rate is still 50° but the rate increases by ½ unit for every increase of 1°. The slope is now ½. The change from A to B will not affect the accuracy of the system, but if a given variety is listed as a 4000-degree day corn using system A, it will be a 2000-degree day variety with system B.

In *system C* a slope of 1 is used, as in system A, but the zero rate has been shifted to 43°. This shift increases the calculated rate value and consequently the number of degree days for a given variety. It also affects the accuracy of the system. If 43° is the correct zero rate, the use of 50° will result in an easily detectable error. That is, the number of degree days calculated for a variety will be greater in warm seasons than in cool ones, and will generally be greater in southern than northern latitudes. The value shown in a seed catalog will thus depend on the temperature conditions under which it was determined.

The critical question is: What temperature-rate relationship is best to use? Unfortunately, heat unit systems were developed before we had t basic information needed to answ this question. System A in Figure for example, is often used for sw corn, but the 50° base temperature too high for a linear system. It m have been chosen because 50° is minimum temperature at which g germination of corn is likely. H ever, the rate of development sho be zero at the base temperature, w no germination occurring.

Three systems compared

Using a statistical technique o inated by A. Ferguson in the Neth lands, along with basic studies corn development conducted at University of Illinois, we have b able to evaluate the temperature-r development of sweet corn m precisely.

Results of our calculations shown by the solid lines in Figur The most conspicuous result is change in temperature-rate relati ship from one phase of corn devel ment to another. In phase 1, relationship is linear, with a temperature of 43°, and is m closely related to soil than to temperatures. In phase 2, it is cu linear, with a zero rate at 49°, m mum rate at 77°, and a zero again at 104°.

In phase 3 the relationship is a linear, with a zero rate in the 40's. However, it is complicated the fact that night temperatures more effective than day temperat The narrower the range betw daily maximum and minimum, faster the rate at the same a age temperature. This complica makes the system too complex most commercial uses. So we fall back on a single temperature relationship from planting to har

The problem created by usi single system is illustrated by dashed line in Figure 2, which sh

linear system with a base temperature of 43° and a slope of 1. In phases 1 and 3 this system will be reasonably accurate, although there will be some error in phase 1 if air rather than soil temperatures are used. In phase 3, also, allowance must be made for a slight error in base temperature and an error due to ignoring the difference in day and night temperatures. However, the real potential for inaccuracy is in phase 2, particularly at high temperatures, when the linear system greatly overestimates degree days per day.

The sweet corn was harvested with 72-percent moisture content. What relationship exists between this point and the stage at which field corn is harvested is unknown to the author. However, the use of a single relationship all the way to harvest clearly carries the potential for serious error under some conditions.

The heat unit system used for field corn is apparently based on the temperature-rate relationship shown by the dotted lines in Figure 2. Above a base temperature of 50°, the slope of the line is 1 until a temperature of 86° is reached. Above this point the slope is zero.

Comparing this system with the rate relationships found for sweet corn, we find that in the first and third growth phases the field corn system underestimates the rate, particularly above 86°. In phase 2, it underestimates up to 84°, then overestimates. The overestimation is less than with a linear relationship. Despite this improvement, however, the author's experience with sweet corn indicates that the field corn system reflects the error that typically results if the base temperature is too high.

Using maximums and minimums

If temperatures are read at 1-hour or even 3-hour intervals, the rate values on the curves for field corn can be used per se. However, if only maximum and minimum daily temperatures are used, then adjustment must be made for values below 50° or above 86°.

To illustrate the problem and its solution, let us first assume that the minimum temperature on a particular day is 56° and the maximum, 76°. The calculation of degree days for that day would be:

$$56 + 76 \div 2 - 50 = 16.$$

If, however, the minimum and maximum were 46° and 66°, the calculation would be:

$$50 + 66 \div 2 - 50 = 8.$$

Substituting 50 for the minimum of 46 is simply a quick way of assessing only the effects of temperatures above 50°, or the point where plants are assumed to start developing.

Similarly 86 would be substituted for maximums above 86°. Thus, assuming a minimum of 76° and a maximum of 96°, we would have this calculation:

$$76 + 86 \div 2 - 50 = 31.$$

Evaluation of field corn system

To the extent that our findings with sweet corn apply to field corn, the following comments can be made.

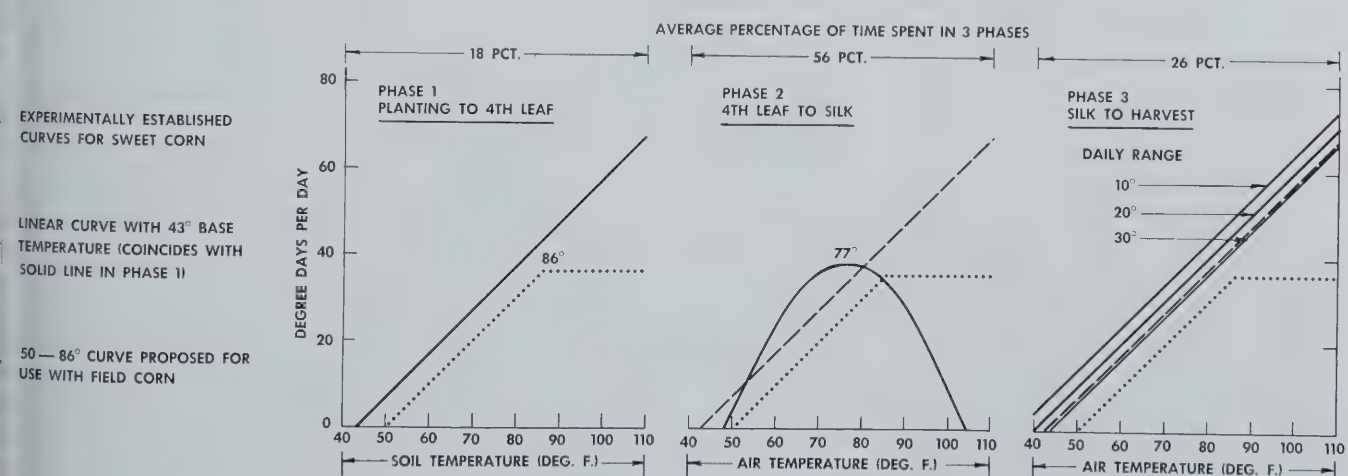
1. As a single system used to describe a varying system of plant development, it should not be expected to give consistent accuracy.

2. The base temperature may be too high. Using a linear system from planting to harvest, we have had the best results with a base temperature in the low forties. The use of a curvilinear relationship gives even more consistent results. If the degree day value calculated for a hybrid tends to be greater in warm weather than in cool weather, a lowering of the base temperature might be indicated.

3. The method of accounting for temperatures below the base temperature or above 86° is not the best, but should be precise enough. It has simplicity in its favor.

A warning to other users

A map has been published showing the degree day values accumulated during normal seasons in various zones of Illinois. Current season growing degree days will also be published periodically. As already noted, changes in base temperatures or in slope alter the degree day value for a variety. Unless you are using the 50-86° system or something very close to it, the published values may be misleading.



Curves developed for sweet corn; curve with 43° base temperature; and proposed curve for field corn. (Fig. 2)

The Future of Our Environment Depends on National Philosophy

O. G. BENTLEY

MAN'S basic urge for survival forces him to seek security against the vagaries of the environment. He has used his cunning and mentality to bypass the slow processes of nature. He has invented machines, exploited natural resources, and controlled the environment through agriculture to produce more food and fiber for himself and the animals that serve him. All these things and many more have dramatically altered the environment in which we find ourselves at the end of the twentieth century.

Since world population is increasing, there is little likelihood that the pressure on the environment will be slowed. More, not less, consumption of goods can be expected, with an attendant depletion of natural resources.

The implications for education and research are immense. Scientists are well aware of the amount and difficulty of the research to be done. However, they have confidence that, given the necessary money and manpower, they can contribute the knowledge essential for environmental control.

Scientists in the College of Agriculture are attacking various aspects of environmental quality (see page 9; also ILLINOIS RESEARCH, Fall, 1970). At the same time, agricultural research is confronted with the task of meeting food needs by the year 2000, when the population is expected to be 50 to 75 percent greater than it is now.

O. G. Bentley is Dean of the College of Agriculture. This paper is based on a talk that he gave at a recent meeting of the American Association for the Advancement of Science.

A philosophy is needed

Despite the difficulty of the research problems facing the scientist, the number one problem, in my opinion, is the need to develop a national philosophy that will guide both scientists and the rest of the population in the attack on environmental pollution.

A national philosophy of environmental control must encompass a knowledge of the price to be paid. Assuming the scientific community can produce technical solutions to environmental problems, every individual in this society will be affected at some level and in some way by the implementation of these solutions. One wonders whether the present enthusiasm for environmental quality is based on an awareness of the personal, social, and dollar costs that will be called for.

In this regard, Robert H. Finch, Counsellor to the President, has remarked: "There is a fatal danger implicit in the growing public clamor for environmental quality. It is the twin danger of 'the passing fad' and of the simplistic solution — and the very appeal of clean air and water, pure food, and rational land use practically *invites* over-simplification. Who, after all, could possibly be *against* any of these inherently desirable goals? Is there any person around who really wants polluted water and air, unsightly mountains of waste, poisons in the food chain, or degraded and depleted living space?"

It seems reasonable to assume that very strict measures will have to be taken if the environment is to be cleaned up in the near future. This could mean strong legal regulation, perhaps complemented by the establishment of a supervisory body with powers unprecedented in the history of the United States.

Are we Americans willing to accept this control in the interest of a better environment? How will we react, for example, if we are told we can no longer use the fireplaces in our homes? How will businessmen react to laws that may be viewed as a threat to our commercial traditions of independence and unorganized use of natural resources?

The problem for business is mainly an economic one. Konrad T. Semrau, who has been doing research on air pollution for 20 years, recently emphasized this point: "Most people think that air pollution control presents a tremendously complicated technical problem. But in most cases the barrier to effective control is not technology, but economics. We know how to do it, at least in a general way; the real question is, at what cost?"

It has been estimated that the cost of eliminating air pollution alone will total some $7.5 billion between 1970 and 1974. Is the American consumer willing to pay this bill in the form of higher prices for a manufactured product?

The costs of pollution control could be especially burdensome for the small businessman. For instance, a small roadside cheese manufacturer who has been making high-quality cheese for many years may be discarding his whey into a nearby stream. If pollution-control measures were strictly enforced, he might not be able to make the needed changes and might have to go out of business.

Universities should take lead

The preceding comments about effects on the average citizen and the businessman refer to the *preventive* or *policing* aspects of environmental control. Perhaps universities should be more concerned with the *maintenance* or *educative* aspects of the problems.

As educators serving the public

iiversities must *first* help establish rationale for attacking environ-ental problems, and *secondly* take e lead in gathering data about these oblems. Will they do this? Will ey adjust programs fast enough to eet environmental needs?

Will universities produce enough aduates to provide the necessary chnical leadership in improving our vironment? And will the universi-s also produce graduates who can sume social leadership, who will in-st on a new kind of politics that phasizes issues rather than ex-piting emotions? Using either di-ct degree programs or extension ucation, can universities produce cial leaders who can help resolve e problems in violence-torn com-mnities such as Cairo, Illinois?

I do not know if universities can do these things, but I think they ould try. The final answer, it seems t me, lies in producing graduates vo are educated in a democratic t dition with highly internalized val-s as to the necessity of maintain-ig the environment and improving t quality of life.

Te people make choices

I would like to conclude with an-cier quotation from Robert H. Ich: "One of the hardest lessons v have to learn — and, as educators, t impart . . . is the utter absence o panaceas and nostrums.

'Patterns of human behavior . . . r lly [are] the key to the entire rge of our environmental concerns. I s people who reproduce, and peo-p who pollute — and it is in the vy process of serving human con-vience that nearly every environ-nntal problem arises.

'Finally, and crucially — it is the pple, individually and collectively, wo now must make the corrective cices . . . who must decide to alter al even to reverse the patterns of tlir own behavior . . .

But the ultimate choices, in this fe society of ours, must be individ-ul choices and those that emerge fn the political process itself. There siply is no other way to make our cmitment stick!"

A Two-Dimensional Approach to ENVIRONMENTAL RESEARCH

R. J. MILLER and W. R. BOGGESS

ENVIRONMENTAL RESEARCH is not new to the Agricultural Experiment Station. Since the Station's inception, research has been conducted on maximizing environmental effects to produce more food and fiber. The success of this effort is seen every time we go shopping in a supermarket.

Unfortunately, these concentrated efforts to increase production of plants or animals have largely ignored the reverse effects — that is, the effects of plant and animal growth on the environment. That the maximization approach toward crop production may no longer be completely valid is seen when we consider the deterioration of our water, land, and air.

At the same time, we cannot sacrifice food and fiber production, for the projected U.S. population of about 300 million people by the year 2000 will require far more of these basic substances than is now being produced. What agriculture must do is to move toward management systems that will maintain both high production and environmental quality.

As described briefly in the Fall, 1970, issue of ILLINOIS RESEARCH, the College of Agriculture has evolved a new two-dimensional approach toward research, extension teaching, and resident education in the area of environmental quality. The traditional departments represent one dimension and the recently formed Council on Environmental Quality constitutes the second. The council is composed of a director, an administrative coordinator, and the leaders of eight task groups.

R. J. Miller is Associate Director of the Agricultural Experiment Station; W. R. Boggess is Head of the Department of Forestry.

Task group areas described

Each task group is investigating some aspect of environmental quality. The eight areas of study were chosen because they are important and because the College already had some research under way in each area, with staff members who could supply the necessary leadership. The task groups and their areas of responsibility are as follows:

Human and metabolic wastes. In the years to come, much of the organic waste from municipal and industrial sewage plants will probably be distributed on agricultural or forest land. This makes sewage disposal an agricultural problem. The disposal of animal waste from concentrated livestock operations has also become an important problem. Many of the difficulties and practices connected with these two groups of waste are similar. They were therefore placed under one task group.

Plant residues and food processing waste. Illinois ranks fourth among the states in the size of its secondary wood-using industries. It also processes over 10 percent of the nation's food. In both the wood-using and food-processing industries, as much as 50 percent of the raw product ends up as waste. Most of the wastes from secondary wood-using industries are dry — such as bark, sawdust, and shavings, and have either been dumped on the land or burned. Food wastes are usually diluted with water and have been added to our streams and rivers.

Erosion and sedimentation. This task group is concerned with the largest single water pollutant — particulate matter from the soil. Besides muddying our streams and filling up our lakes, soil eroded from agricul-

tural land carries various chemicals such as phosphates and pesticides.

Pesticides and pest control systems. Chemical pesticides are essential for producing the quality and quantity of food that we need, but integrated pest control sytems should be developed in which chemicals are combined with naturally occurring or introduced biological controls to combat weeds, insects, and diseases.

Plant nutrients as water pollutants. We need to determine whether plant nutrients, primarily nitrogen and phosphorus, are major contributors to water pollution. If they are, what are the relative amounts from fertilizers, from feed lots, from runoff, and from erosion? And how do these amounts compare with the amounts from other sources, such as municipal treatment plants? Where problems exist, how can they be solved?

Extension education as it relates to environmental quality. Before technical information can be used to relieve our environmental problems, it has to be disseminated to the people in a meaningful way so that they can make wise decisions. The extension task group has the responsibility not only of distributing the information as it becomes available, but also of informing researchers where there are gaps in our knowledge and where there are problems.

Policy evaluation as related to environmental quality. Science can provide solutions to problems, but the choice and action is an individual decision. Before an individual, be he at the family, municipal, state, or federal level, can make wise choices, he must be aware of alternative courses of action. The possible consequences of various alternatives have to be studied, understood, and presented to the public.

Human interaction with the physical environment and social assessments. Much has been written or said about various aspects of environmental degradation, but little is known about the nature or amount of environmental improvement that individuals want or will accept. Such knowledge is necessary before meaningful and long-lasting programs can be implemented.

Organization of task forces

Each task group is composed of about seven members who represent the various disciplines and departments needed to provide necessary background knowledge and expertise. Members are from the College of Agriculture, other colleges in the University, and various other agencies, particularly the three State Surveys (Natural History, Water, and Geological). The task groups have determined the state of the art in their area and decided what programs are needed or should be undertaken at the University of Illinois.

This system gives us the benefit of many types of backgrounds, training, and experience, and provides considerable flexibility. If a group is no longer needed, it can be disbanded without difficulty because staff members remain in their subject matter departments. Promotions and other awards come through the departments rather than the Council.

As programs develop, task group members may become involved in the actual project themselves, or they may provide persuasive leadership in developing working groups. Task groups will develop and coordinate master projects in their area or related areas, and from these will come the actual working plans.

This approach to research is in contrast to the classical College of Agriculture approach, in which the Dean administers programs through three directors and the department heads. The College is, by statute, responsible for research through the Experiment Station, extension education through the Cooperative Extension Service, and resident education through the Director of Instruction. Each department is responsible for all three areas of work, with individual staff members being assigned specifically to one or two of the areas.

The departments are organized around some segment of agriculture and have not generally developed interdepartmental-interdisciplinary research. The Council, on the other hand, is not a department in itself. It has been set up by the dean, directors, and department heads specifically to encourage and coordinate interdisciplinary research on environmental problems. Such an arrangement should allow us to focus efforts on agriculture's contributions to environmental quality, while maintaining essential production research.

Advantages

In these times of diminishing research support and a questioning public, it is imperative that we use our existing talents and facilities as effectively as possible, without going through the costly and time-consuming process of creating new units to work on societal problems. The University contains all of the ingredients (and the College of Agriculture most of the ingredients) needed to attack many environmental problems.

The unique advantage of Colleges of Agriculture is their three-fold responsibility for research, extension, and resident instruction. Traditionally, they have been concerned with societal problems. Most other colleges in the University are primarily responsible for undergraduate and graduate education. Their research projects have generally developed around interests of individual staff members or graduate training requirements — usually there is no formalized research program. Nor do they have feedback mechanisms for exchange of information between the people and the researcher.

We believe that, in organizing the Council on Environmental Quality, the College of Agriculture has developed a sound and logical approach to environmental problems. This approach is designed to get the maximum benefit from existing facilities and provide for the most efficient use of both material and human resources. It is truly interdisciplinary, involving meaningful communications among many specialists. We believe that this type of structure can be expanded, and that the Council, or similar units, can work in full partnership with other organizations on the campus or elsewhere.

ɅARIHUANA: Identification and Control

.ERY L. KNAKE and DENVER CORN

ɅARIHUANA (*Cannabis sativa*), also called wild hemp, has been und in Illinois for over a century. : various times it has been inten- ɲnally cultivated for its fiber. The ggest effort in this direction came ıring World War II, when our sup- y of fiber for rope from the Philip- nes was cut off.

Now wild hemp can be found in ıce rows, along ditches, and in ıher non-crop areas. In itself it is ıt a serious problem for farmers, ıce it is seldom found in cultivated ops. However, undesirable trespas- rs looking for marihuana may be- ıme a decided nuisance. And, of ıurse, the use of marihuana after is harvested poses a problem for of society. In 1969, marihuana was ded to the list of noxious weeds in inois, so allowing it to grow on ur land is unlawful.

Marihuana is an annual plant that ows from seed each year. In Illinois owth begins in late April or early lay. Leaves are palmately com- ɪund, with each leaf made up of an d number of leaflets, commonly e, seven, or nine. The leaflets are ıg and narrow, have saw-toothed ges, and are joined at the base, newhat like the fingers on your ıd.

Plants may be either male or fe- ıle. Male plants wither and die er they produce pollen. Female ınts, which are leafier than the ıles, may remain green and vigor- until frost. Plants flower about ly, and the females produce seed n afterwards. The seed is mottled y and brown and is shaped like a niature clam shell.

The chemicals which account for effects of smoking marihuana are ed tetrahydrocannabinols (THC). ey are found in the resin on the face of various plant parts, espe- ly on female plants.

Marihuana should definitely be trolled before it produces seed. It is not known exactly how long the seed will remain viable in the soil. But if no new seeds are added to the soil and those present either germinate or rot, several years of conscientious control can reduce the problem.

Seeding desirable grass such as smooth brome in fencerows can provide a vigorous, competitive growth to greatly discourage marihuana and other weeds. Desirable grasses also provide good wildlife cover and protect the soil from erosion. Where feasible, desirable crops can be planted to discourage marihuana.

For small patches, pulling or hoeing is effective. Mowing and tillage will also give control.

Results of research at several locations in Illinois in 1970 indicate that several herbicides can give good control of marihuana if plants are sprayed in May or June when not over a foot or two high.

Silvex or 2,4,5-T are both quite effective at rates of about 1 pound active ingredient per acre applied with 25 to 50 gallons of water to wet the plants well. Since 2,4,5-T is not supposed to be used along ditches, silvex is preferred. The ester form of 2,4-D applied in a similar manner is also effective and gives better control than 2,4-D amine.

Silvex, 2,4,5-T and 2,4-D ester are phenoxy herbicides. They must be applied with great care to avoid injuring nearby soybeans, gardens, or other desirable plants which might be susceptible to the spray. One advantage of the phenoxy herbicides is that they do not kill desirable established grasses.

Amitrole-T, at 2 pounds active ingredient per acre applied as a spray, has given exceptionally good control of marihuana. Amitrole-T is safer than the phenoxy herbicides where there is risk of injury to nearby desirable plants. However, it should not be sprayed directly on desirable plants, including grasses. Although amitrole-T costs more than the phenoxy herbicides, most patches of marihuana are relatively small and would not require much expenditure for chemical.

By controlling marihuana, you'll be improving the quality of our environment and will be making a definite contribution to society.

Each marihuana leaf is made up of an odd number of long narrow leaflets.

Unsprayed and sprayed marihuana. For best results, spray in May or June.

Ellery L. Knake is Professor of Weed Science; Denver Corn is Senior Extension Adviser in Agriculture, Sangamon County.

SASSAFRAS PLANTATION

Is Well Worth a Traveler's Stop

R. G. RENNELS

MANY PEOPLE travel through eastern Illinois on U.S. Highway 36, but probably few of them notice one of the most picturesque stands of planted sassafras in existence.

These trees are located on the north side of the road 2½ miles east of Tuscola. The farm where they grow is owned and operated by St. Clair Helm, Jr., whose father bought it in 1934.

Mr. Helm takes great pride in the trees and gladly supplied as much information as he could about their history. Earl Jones of Tuscola, who lived on the farm from the mid-1920's until the early 1940's, also furnished factual information about the plantation. The information obtained from these two men was supplemented by talking with other area residents and by making on-the-ground observations, tree counts, measurements, and increment borings.

No one was able to tell the exact year that the sassafras was planted. One man in his 80's said that the trees were big 50 years ago. Another elderly native of the area said that he had observed the plantation with great interest since the early 1900's.

A history of Douglas County, published in 1910, does not mention the sassafras planting, but does tell us that two brothers, Oliver and Merrill Hackett, bought the land in the 1850's. On the basis of all the available evidence, there appears to be no doubt that Oliver Hackett planted the grove sometime between the late 1850's and the late 1860's. The stand has been known as "Hackett's grove" at least since the early 1900's, and probably longer.

The trees and stumps remaining today indicate that at least 2 to 2½ acres were originally planted. Long-time observers are of the opinion that the planting may have covered 4 or 5 acres in the beginning.

One can only conjecture as to why Oliver Hackett planted this sassafras grove. The medicinal and flavoring qualities of sassafras are well known; the wood is good for smoking or curing meat; it is useful for fuel and for a wide variety of building purposes; and the fall colors of the foliage are beautiful in a good year. Perhaps Hackett considered all of these advantages. One may even suspect that he realized his efforts would leave the land and the landscape better than he found it.

Age and spacing of trees

As already mentioned, it is believed that the grove was planted about 1860, give or take a few years. To learn more about the age of the plantation, increment cores were taken in 1970 from trees distributed over the area. The cores, about 3⁄16 inch in diameter, were removed from trees with a hollow auger known as an increment borer.

According to ring counts in the cores, the average age of the trees is 105 to 107 years. One tree, for example, had a ring count of 106 at the 4½-foot level. Since one year is needed for a tree to reach 4½ feet in height, this tree had been growing at least 107 years, or since 1863.

However, the old trees may be a few years older than the ring counts indicate. Deer and rabbit damage, which may have been considerable in the last half of the nineteenth century, could have nipped back early growth. Also, it is possible, though not probable, that domestic livestock browsed in the area the first few years after planting. If so, this could cause an error in pinpointing tl precise year of planting by the a nual ring procedure.

It is no longer clear whether fai uniform spacing was used througho the plantation between rows and b tween trees in the rows. Eviden remains, however, that the trees we planted in rows 15 to 16 feet apa In some portions of the remaini stand, distances between trees su gest that at least some of the tre were originally spaced 6 to 10 fe apart in the rows.

Present condition

So many top limbs have been l over the years from various cau that the average height of the maining trees does not indicate t suitability of the site for sassafr Average height of the trees in 19 was a mere 32½ feet. Heights rang from 12 feet, that of a live tru stub, to 61 feet, the height of t tallest tree in the stand with the t still intact. Most of the remain trees attained a height of 45 to feet before their physical decli Average diameter of the trees at d.b.h. level (diameter at 4½ f above the mean ground line) is 2 inches. The largest has a diame of 35.6 inches; the smallest, 2 inches.

Clear trunk length of the tree variable in different parts of plantation (see cover picture), a the case in most native forests, flecting differences in stand den and other competition factors t affect the retention of the lo branches. Obviously some trees w large, low side branches have ample growing space for many ye if not for their entire lifetime.

Neither past nor present ow have logged sassafras from this p tation for lumber. (As far as ca determined, the few cut stumps longed to dead or seriously dama trees.) Board-foot volume of the t today, however, will be of inte if lightning-struck trees or w thrown trees are harvested. A with 24 feet of merchantable he (free of large side branches) a d.b.h. of 28 inches would con

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R. G. Rennels is Associate Professor of Forestry.

out 480 board feet by the Interna- nal Log Rule (¼ inch). Sassafras wn into lumber is suitable for roof ards, sheathing, and other uses; reasonably resistant to decay; and ils well. Unfortunately, even with good durability of sassafras, many the trees in this planting are now ghly defective due to lightning ikes, grazing damage, and over- turity to the point where their ld of sound, high-quality lumber uld be greatly reduced.

nagement practices

Some of the history of the manage- nt practices (or lack of practices) d for this plantation over the years been lost to us. However, it is dent that domestic livestock graz- in the early years after establish- nt was light or, more likely, that grazing was permitted for several rs. Otherwise the present large es either would not have survived would not have attained their d trunk form and development. For a period of several years before l after 1934, the plantation either not grazed at all or was lightly zed. During those years, according the present owner, thick under- wth, largely of sassafras, became ablished over the area. Much of sassafras was likely of root-sucker gin, although some seedling growth y also have been present.

Within the past 10 years, the area been lightly grazed by Angus cat- Mowing has also been employed keep down most of the under- wth. Although partially due to tning damage and wind breakage, top dieback of several of the old s suggests that soil compaction root damage by livestock may have contributed to the trees' sical decline. In addition to the dieback, other indications, such he narrow annual rings of wood down by the trees in recent years, gest that they are approaching sical overmaturity.

e a look

The next time you cross Illinois Highway 36, pull off the road and a look at sassafras trees that are not worthless brush taking over aban- doned worn-out land, but are stately trees planted by man when the high- way was a mere wagon road. The enjoyment that they give is a re- minder that some of our greatest values cannot be measured in dollars and cents.

Nonregistering Campers—Who Are They?

ROBERT A. YOUNG

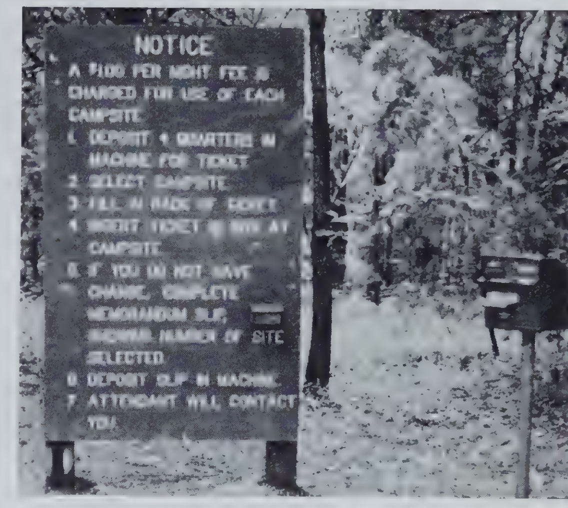
At many campgrounds fees are now collected by a machine instead of an attendant, and registration is voluntary. This is the system used by the U.S. Forest Service at the Lake Glendale Recreation Area in southern Illinois. A sign at the entrance requests campers to buy a permit from a coin-operated machine. Upon paying his fee, the camper receives a card which is both a receipt and a registration form.

Forest managers use registration cards to obtain the information they need to plan and manage our forests in the public interest. The cards may themselves contain questions about the campers' preferences, or they may provide a mailing list for future questionnaires.

However, many people do not fill in the cards. At Lake Glendale, about 30 percent of the campers fail to register during a season. Do these people have different views than those who register? If so, information obtained only from the registered campers might be a misleading basis for making management decisions.

To learn more about the nonregistering campers, the Forestry Department of the University, in cooperation with the U.S. Forest Service, studied campers at Lake Glendale during the 1969 camping season. We checked the campground daily and asked every new camper for his name and address. To identify the nonregistering campers, we compared our list with the list of registrants.

At the end of the season, we mailed questionnaires to 150 registered campers and 100 who hadn't registered. The questions concerned general background, social and economic characteristics, past camping experiences, and camping preferences. Questionnaires were returned by 91 percent of the nonregistrants and 81 percent of the registrants.



Entrance to Lake Glendale campground.

Nonregistrants differed from the registrants in several ways. On the average, nonregistrants had fewer children, had spent more time camping at Lake Glendale during the three previous seasons, and had their first camping experience at an earlier age.

The nonregistrants also had different ideas about what improvements were needed. They were more interested than the registrants in firewood, a store, ice machine, and laundry. They were less concerned with better maintenance, electrical hookups, and organized activities.

The two groups did not differ appreciably in average ages of husbands, wives, and children; educational levels; family income; size of town where the campers were raised; membership in conservation organizations; or frequency of outdoor recreation experiences in childhood.

Robert A. Young is Forester, Department of Forestry.

LABELS ON READY-TO-WEAR CLOTHING

How many garments carry labels that give needed information on care and fiber content?

MARY JO FICKLE

WITH the increasing numbers of various fiber, fabric, and finish trade names, consumers everywhere are realizing the need for consistent and informative labeling on fabrics and ready-to-wear garments.

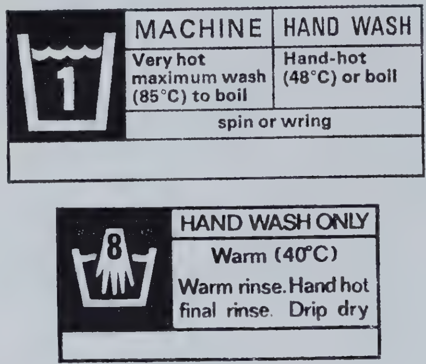
To help simplify the problem, the Federal Trade Commission drew up the Textile Fiber Products Identification Act, which was passed by Congress in 1960. This legislation requires that the generic (group) names of fibers comprising a textile fabric be listed by percent, in order of importance. This labeling must appear on a hang tag or other type of label accompanying a fabric or garment.

Merely supplying the fiber content, however, does not always provide the consumer with enough information to care for the item. Moreover, fiber content alone provides only a limited indication of performance characteristics (such as colorfastness, dimensional stability, and abrasion resistance).

In an attempt to provide a more satisfactory product and develop consumer confidence in trademarks, some business firms are voluntarily providing more informative labeling. This may be done by fiber, fabric, or garment manufacturers — or even by large retail firms.

Care information on a hang tag eliminates at least some of the guesswork in cleaning the item. *Guarantee programs* not only assure the consumer of recourse if an item fails, but also build a "quality reputation" for the manufacturer. *Performance claims* on a label indicate the level of quality and are advertising media as well.

Mary Jo Fickle is Assistant Professor of Textiles and Clothing.



Two of the sewn-in care labels used in the United Kingdom.

However, all is not solved by this voluntary labeling. Often the care instructions are brief and non-specific, allowing several interpretations. Sometimes care instructions for an assembled garment differ from those for face fabric alone. Performance claims may lack an address or instructions for returning unsatisfactory items. Guarantee programs are an advantage for the consumer, but the guarantor often finds them expensive.

It is obvious that a good consistent system of relaying proper information is needed. In the United Kingdom, the Home Laundering Consultative Council has devised a care labeling scheme. Sewn-in labels with care symbols and written instructions provide the consumer with exact care procedures. These procedures are also described on detergent packaging.

Switzerland has a similar system by which care symbols are included on permanent sewn-in labels. These voluntary labeling procedures are valuable because of widespread participation by manufacturers.

Several years ago the National Retail Merchants Association tried to institute such a system of symbols in the United States. Unfortunat the program did not receive enou support to become established.

With the current wave of consu erism, there is renewed interest providing consistent, informative beling, permanently affixed to a parel items. A trade regulation this end is under consideration the Federal Trade Commission. Su a regulation will not be made quick however, because of the controv sial nature of labeling standards.

To the manufacturer, a perman label means added costs both for labels themselves and the labor apply them. Furthermore, a perm nent label is likely to increase cu tomer returns, merely by serving a reminder of trade names and c expectations.

Market survey conducted

To ascertain the extent and nat of voluntary labeling on appare local retail stores, a survey was cently conducted by a Univer class in clothing selection and des The survey was limited to wome juniors', and girls' dresses or ens bles. These garments are made greater diversity of fabrics and more different manufacturers t are men's and boys' clothing.

Twelve stores in Champaign- bana were included in the sur For purposes of comparisons wi price ranges, the stores were div into three groups:

1. Small chain or indepen stores (moderate to high prices, store labels).

2. Large chain stores (low moderate prices, some store lab

3. Large chain or discount st (budget to low prices, some labels).

Students collected and evaluated ›el information on 20 different ·les in each size group. Two types tags were evaluated: permanent or nporary sewn-in tags and hang ;s. Since the ideal tag is a perma- nt sewn-in label giving both fiber ntent and care information, such ;s and the completeness of their in- mation were particularly observed. ›te was also taken of guarantees claims and the presence of refer- ce addresses.

wn-in labels

Many garments do not have any rmanent sewn-in labels (Table 1). oreover, most of the permanent ›els do not give fiber content or re instructions. The notable ex- ›tion is girls' garments in Group stores. In this group were found ıny store labels providing care in- mation and, in some cases, fiber ntent. Girls' garments, as a whole, peared to have more informative rmanent labels than juniors' or men's.

Temporary sewn-in tags are more en used than permanent labels to ›vide fiber content (Table 1). me manufacturers have begun to d care information to this label. ıe temporary label at least se- res fiber content and care infor- ıtion until the consumer wears the garment. Then, however, it is often removed and discarded; few consumers keep an accurate or usable "label file."

Hang tags

The inexpensive, easily applied hang tag is frequently used by manufacturers (Table 2). Fiber content, especially if it does not appear on sewn-in labels, is often listed. In this study, care information on hang tags was usually found to be quite complete and was often supplied on garments having little sewn-in information (that is, women's and juniors'). The unfortunate fate of many good hang tags, however, is to fall unnoticed on dressing room floors. Consequently the ultimate consumer does not always have the benefit of information supplied by manufacturers.

Guarantees and claims

Although guarantee programs are not new, there are few in wide scale use. Performance claims, on the other hand, are becoming more common, giving the consumer at least some basis for evaluating performance (Table 2). Hang tags often include statements about the colorfastness, washability, and resilience of fabrics. In this study performance claims were observed particularly on women's garments in groups 2 and 3.

Addresses of companies or manufacturers displaying trademarks on labels are not required information. In at least some cases, however, addresses were found (Table 2). Addresses almost always accompanied guarantees and sometimes appeared with claims.

ble 1. — Occurrence of Sewn-in Tags and Information, Girls', Juniors', and Women's Clothing, Three Store Groups

oup	Permanent sewn-in tags			Temporary sewn-in tags		
	One or more tags present	Fiber content given	Care information given	One or more tags present	Fiber content given	Care information given
			percent of garments			
s'						
....	85	18	18	77	70	2
....	92	33	60	67	65	10
'.....................	25	15	5	83	80	3
ver....................	67	22	28	76	72	5
iors'						
....	83	10	6	68	13	1
....	32	5	10	65	23	0
....	55	8	0	98	50	38
ver....................	57	8	5	77	29	13
men's						
....	69	8	2	74	27	1
....	40	10	12	65	22	3
....	20	5	0	83	38	0
ver....................	43	8	5	74	29	1

Table 2. — Occurrence of Hang Tags and Information, Girls', Juniors', and Women's Clothing, Three Store Groups

Group	One or more tags	Fiber content	Care information	Guarantees or claims	Addresses
			percent of garments		
Girls'					
1.......	93	42	70	25	0
2.......	68	33	57	25	27
3.......	90	58	43	10	5
Aver.....	84	44	57	20	11
Juniors'					
1.......	70	59	49	3	8
2.......	90	73	62	10	10
3.......	100	88	75	35	10
Aver.....	87	73	62	16	9
Women's					
1.......	97	68	71	18	12
2.......	82	82	80	45	28
3.......	95	93	90	45	30
Aver.....	91	81	80	36	23

Outlook promising

Nearly all garments in this study had fiber content labeling in accordance with Federal Trade Commission regulations. Only 8 percent of the garments carried no fiber information. Perhaps the most encouraging aspect of labeling practices as observed is that the percent of garments bearing no care labeling was also low — 20 percent. Only 5 percent of the garments had neither fiber content nor care labeling.

Although voluntary permanent labeling with care information was found on relatively few garments, the quality and amount of care instructions on hang tags seem to indicate at least some effort on the part of manufacturers to comply with consumer wishes. With encouragement, the majority of manufacturers may adopt a policy of permanent labeling.

Seven Years of Alfalfa Harvests Deplete Soil Phosphorus and Potassium Values

W. M. WALKER, J. A. JACKOBS, and T. R. PECK

SEVERAL successive alfalfa crops can rapidly utilize large applications of phosphorus and potassium fertilizers. This fact became readily apparent during a seven-year experiment to determine how rate, method, and timing of fertilizer applications affect alfalfa yields. The study was conducted on a Blount silt loam at the Northeastern Illinois Research Center near Elwood.

In this article we are concerned with just one aspect of the larger study — the fertility status of the plots where phosphorus (P) and potassium (K) were incorporated into the seedbed. (Results of the total study have recently been published in Illinois Agricultural Experiment Station Bulletin 738.)

Seedbeds were prepared in August, 1962. Fertilizer was incorporated into the soil at the following rates per acre: (1) 132 pounds P; (2) 264 pounds P; (3) 747 pounds K; (4) 132 pounds P plus 747 pounds K; (5) 264 pounds P plus 747 pounds K. Control plots received neither phosphorus nor potassium.

Every year the soil was sampled in early spring and after each clipping. Values reported for each year in Tables 1 and 2 are thus averages of several samples.

Soil phosphorus

As would be expected, rather large values for soil P were obtained in 1963 on plots receiving high rates of P fertilizer (Table 1). Even on plots receiving only K fertilizer, available soil P was considerably higher than on the untreated plots. A similar effect has been noted by other research workers. Probably the high rate of potash salts increased solubility of the native soil phosphorus.

Between 1963 and 1969, soil P decreased markedly on all plots. Yield and phosphorus content of alfalfa were highest on plots receiving P fertilizer; hence soil phosphorus declined fastest on these plots. Even so, the effects of fertilizer P on the soil levels of available P were still apparent in 1969.

Since 1965, the decline in soil P on the plots receiving no fertilizer has been rather limited. Probably the soil is approaching an equilibrium where a relatively constant level of available phosphorus will be maintained by soil minerals. However, it is unlikely that high alfalfa yields can be produced on these plots without fertilizer.

Soil potassium

The increase in soil K due to fertilizer K is shown in Table 2. With continued removal of alfalfa forage, soil K values decreased on all plots.

After 1965, only a slight decline in soil K occurred on plots receiving no K fertilizer. Evidently, an equilibrium is being approached in soil K values, with only slight annual decreases occurring as the alfalfa utilizes K released by native soil minerals. As was observed for low soil P values, it is unlikely that high alfalfa yields can be obtained at these low soil fertility levels. Soil K values from plots receiving both P and K fertilizers indicate that all the fertilizer K had been utilized by the end of the growing season in 1966.

Table 1. — Soil Test Phosphorus Values

Year	Fertilizer treatment, lb. per acre					
	None	P, 132	P, 264	K, 747	P, 132 K, 747	P, 2[illegible] K, 7[illegible]
	P_1, lb. per acre					
1963	14.6	91.0	161.0	22.0	119.0	256
1964	12.5	62.7	104.7	16.5	60.0	186
1965	9.8	59.3	132.3	14.6	59.3	146
1966	8.2	30.0	87.0	11.2	45.7	78
1967	8.5	31.3	74.7	10.8	47.0	86
1968	8.5	20.0	52.0	9.0	31.0	62
1969	7.7	15.3	35.0	9.0	21.7	43

Table 2. — Soil Test Potassium Values

Year	Fertilizer treatment, lb. per acre					
	None	P, 132	P, 264	K, 747	P, 132 K, 747	P, 2[illegible] K, 7[illegible]
	K, lb. per acre					
1963	185	176	178	716	725	7[illegible]
1964	168	166	164	616	506	5[illegible]
1965	134	131	128	448	322	3[illegible]
1966	130	117	121	296	224	2[illegible]
1967	134	114	113	220	163	1[illegible]
1968	127	124	125	179	135	1[illegible]
1969	122	111	116	166	132	1[illegible]

Continued soil analysis needed

Results from this experiment show that soil test values declined rather rapidly as nutrients were removed from the soil by alfalfa. Low soil test values were probably maintained by the release of nutrients from native soil minerals. This maintenance level is related to soil characteristics, and a specific value would only characterize a particular soil for a specific crop.

Monitoring the soil fertility status of alfalfa fields through soil analysis appears to be a useful method of determining when fertilizer should be applied.

W. M. Walker is Associate Professor of Biometry and Soil Fertility; J. A. Jackobs is Professor of Crop Production; and T. R. Peck is Associate Professor of Soil Chemistry.

ELENET – A New ducational Tool lelps Extension ervice Reach Vider Audience

W. VERNON

HE COOPERATIVE EXTENSION Service has a new educational tl known as TeleNet. This is a vate telephone network linking tether 19 stations, most of them in inty Extension office buildings. e network will soon be expanded t 23 stations.

Amplification of incoming voice snals permits educational programs t be heard by large Extension audi-ces. Every station may transmit as ll as receive audio messages. How-er, TeleNet does not have visual tnsmission capability.

By means of TeleNet, Extension scialists can meet simultaneously h two or more groups. In fact, a stations or any combination of stions may participate in a given pgram. Total participation in any pgram may exceed 1,000 people h any number of contributing itructors.

The use of TeleNet represents one vy in which CES is meeting the dnands of an increasingly diverse cntele. People are wanting more imediate solutions to their prob-ls, and more depth to the knowl-ee upon which these solutions are bed. CES has organized the state i multi-county areas, so that more svices and programs can be offered tn is feasible on a single-county bis. When the TeleNet network isinished, it will reach into every nlti-county area, enhancing the pos-silities for educational services.

A TeleNet presentation requires tmwork from a large number of people. To begin with, the presenter of a program needs to confer with on-the-site instructors (usually county or area Extension advisers) so that the program will meet the needs of local audiences.

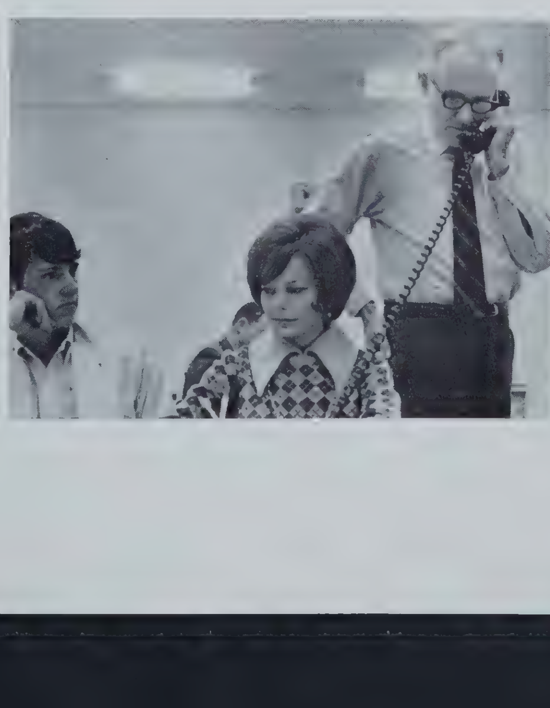
Since visual materials are usually necessary to enchance the effective-ness of an educational presentation, the presenter consults with artists and photographers in the Office of Agricultural Communications, who assist in the visualization of concepts. Planning has to be done far enough in advance that the visuals can be produced and sent to the participat-ing stations before the program is given. The visuals are shown to the local groups on cue from the pre-senter.

During the presentation, the pre-senter is handicapped by the lack of visual cues that he would get if addressing the audience in person. The on-the-spot instructor helps to overcome this handicap by interpret-ing and verbalizing these cues and passing them on to the presenter. In addition, the instructor may relay questions and comments from the audience. However, enough handsets are provided that the "students" may themselves respond to the presenter if they want to.

With TeleNet, we hope to learn some of the techniques of remote education without diminishing other Extension commitments. Remote teaching is not new for CES in Illi-nois. But previous experiences were limited and most advisers did not have the opportunity to participate.

TeleNet stations are in operation at Carbondale, Dixon Springs Agricultural Center, Benton, Belleville, Vandalia, Effingham, Jacksonville, Springfield, Rushville, Decatur, Lincoln, Bloomington, Pontiac, Galesburg, Moline, Joliet, St. Charles, Rockford, and Urbana.

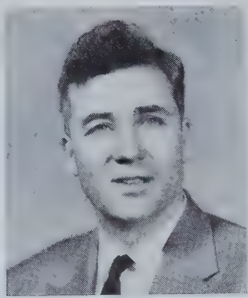
Efforts should be renewed to iden-tify our audiences, determine their real needs, and work with them in developing meaningful objectives. Re-search should also be done on the optimum number of groups that can be served simultaneously, the number of stations that can respond satisfac-torily, and effective teaching team size. In other words, the success of the investment in TeleNet equipment will require a corresponding investment of time in learning to use TeleNet effectively.

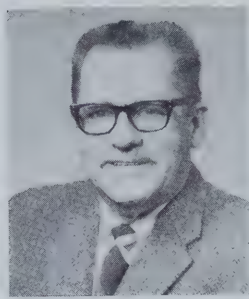


Fay Sims, Associate Professor of Farm Management Extension, was the on-the-spot instructor in Decatur when a Farm Management Workshop was recently conducted via TeleNet. Here he telephones a comment to Franklin J. Reiss, who was presenting the program from Mumford Hall, Urbana. With Professor Sims are Mr. and Mrs. David Cribbet, participants in the workshop.

E. V. Vernon is Assistant Professor of Agricultural Communications.


Alexander


Hannah


Petty


Russell


Salisbury

Five Faculty Members Are Honored in Paul A. Funk Recognition Program

THE FIRST FIVE College of Agriculture faculty members to receive cash awards under the Paul A. Funk Recognition Program were announced April 23. Each award was $1,500.

Funds for the awards were provided by the Paul A. Funk Foundation of Bloomington. The recognition program, which is to be an annual event, is a memorial to the late Paul A. Funk, who died in 1967. A principal in the Funk Bros. Seed Co., Paul Funk spent his life in agriculture. He attended the University of Illinois College of Agriculture as a member of the class of 1929.

As stated by trustees of the Funk Foundation, the purpose of the recognition program is "to recognize outstanding performance and high achievement among the faculty of the College of Agriculture at the University of Illinois as they work for the betterment of the total field of agriculture — agriculture being described in its broadest connotations. It is also the expectation that this program will serve as a stimulus for excellence in teaching, research, and extension."

The College has the responsibility for selecting the recipients. Nominations for the 1971 awards were made by faculty and students and were evaluated by three screening committees named by the Education, Research, and Extension Policy Committees of the College. Final selections were made by a committee composed of the Vice Chairman of the Faculty Executive Committee, one member from each screening committee, and three at-large members named by the Faculty Executive Committee.

The five recipients, and the major achievements for which they were honored, are as follows.

DENTON EUGENE ALEXANDER

Dr. Alexander is an outstanding teacher and an insightful researcher in plant breeding and genetics.

His superior teaching was recognized in 1959 when students presented him with their first Outstanding Instructor Award. In 1967 the University of Illinois Alumni Association listed him as one of the six outstanding instructors at the University. With a contagious enthusiasm for science, he can inspire students to develop to their full potential.

He has exceptional ability to apply basic scientific principles to the solution of practical problems in plant breeding and genetics. A good example is his use of a nondestructive technique for evaluating single seeds for oil content. This has led to the development of very productive plant breeding procedures.

In 1965 Dr. Alexander reported that the ratio of oleic-linoleic acids in the maize kernel is under simp Mendelian control. He has also vised a system of mass production corn autotetraploids based on a rec sive gene, elongate. He used this g to generate autotetraploid corn po lations from which he has collec numerous data that are particul useful to evolutionists.

Dr. Alexander was instrumenta establishing the Illinois Corn Bre ers' School, which annually prov a two-day review of new devel ments in genetics and breeding Illinois commercial corn breeders.

In 1970 Dr. Alexander was elec to the Russian All-Union Academ Agricultural Sciences. He was the American to win this honor, the hi est that Russia gives to agricult scientists.

HAROLD WINFORD HANNAH

A brilliant classroom teacher, Hannah has also excelled in adm istration, research, Extension, international agriculture.

According to one student st ment, "Hannah is a superb instru . . . His enthusiasm, organization, mastery of the material he pres his personal interest, and his f nating personality, recommend highly."

As proof of their regard for teaching ability, students prese

. Hannah an Outstanding Instructor Award in 1962.

In the 1930's Dr. Hannah initiated the College's agricultural law program — the first of its kind in the United States.

Through the years he has served with distinction in a variety of capacities — as director of the agricultural program; head of a special University program for returning veterans of World War II; associate dean of the College in charge of teaching; consultant for the state soil conservation program; director of groups assisting with new universities in India and Pakistan; and chairman of dozens of committees and commissions, both on and off the campus.

Of Dr. Hannah's many accomplishments, two in particular stand out. First, his studies were instrumental in the development of a drainage code which was adopted by the Illinois General Assembly in 1955, replacing previous acts. Second, from 1955 to 1957 Dr. Hannah developed a blueprint for Uttar Pradesh Agricultural University, which was the basis for the establishment of that university by the Indian Government.

His publications include six books, bulletins and circulars, and about articles.

WARD BLISS PETTY

Many entomologists consider Dr. Petty to be the outstanding Extension entomologist in the United States. For more than a quarter of a century he has worked with other entomologists, pesticide dealers, custom spray operators, farm advisers, and farmers to develop a statewide pest-control program that has served as a model for many others.

A major element in Dr. Petty's pest control program is his encouragement of interdepartmental coordination. He also initiated one of the country's most agricultural chemical training schools — the Illinois Custom Spray Operators' Training School.

He has developed a weekly report on current and potential insect problems and their control, which is sent to ,800 subscribers. His information programs range from specific insecticide use recommendations for individual farmers and homeowners, to advice for the state legislature on legal regulations affecting pest control.

Dr. Petty has worked intensively with county Extension pest-control programs, developing close working relationships with county personnel. These relationships have led to new concepts in field teaching now used with advisers, industry representatives, and farmers in Illinois and other states.

Dr. Petty's pest control program has been effective. Because of its timeliness in alerting Illinois farmers to potential insect problems, it increases agricultural income. Because of its emphasis on safety, it saves human lives.

HARRY GOULD RUSSELL

Professor Russell is one of the most respected livestock Extension workers in the nation. His many awards are evidence of the high esteem in which he is held by other livestock specialists.

During nearly 35 years of dedicated service to agriculture, Professor Russell has pioneered in the development and growth of several livestock Extension programs.

He played a major part in the establishment of performance testing programs for Illinois beef cattle, sheep, and swine. At the national level, he helped develop the certification program now in use by all swine breed associations, and he served on the type committees for polled shorthorn beef cattle and for all the major breeds of swine.

One of the first to see the need for meat-type hogs, Professor Russell has worked to convince producers and educators that there was a need to improve hog types. As a judge at numerous 4-H livestock shows, he has taken advantage of the opportunity to teach youngsters the value of meat-type hogs.

He was instrumental in developing the first cooperative feeder cattle auction in Illinois in 1950. This sale, and other cooperative livestock sales throughout the state, have greatly helped improve the quality of Illinois livestock and the economic position of small livestock producers.

The first Extension Award of the American Society of Animal Science was presented to Professor Russell in 1959. He has also received the USDA Superior Service Award and the National Service to the Swine Industry Award.

GLENN WADE SALISBURY

During more than 30 years of research on reproductive efficiency of dairy cattle and on artificial insemination, Dr. Salisbury has compiled an impressive record of "firsts."

He was the first to report studies using the citrate extender for semen which is still in almost universal use; the first to add antibacterial agents to semen with a marked increase in conception rates; and the first to show that semen could be extensively diluted without loss of fertility. He has also made important contributions regarding the site of insemination and the factors affecting spermatozoan metabolism.

His achievements have often been due to his willingness to question accepted ideas. For example, his proof that semen can be extensively diluted to breed a large number of cows came at a time when most researchers believed that this was not possible.

As another example, many animal breeders believed that frozen spermatozoa would remain fertile indefinitely. However, Dr. Salisbury proved that frozen semen does significantly decrease in fertility with time and that embryo or early fetal loss increases according to rates which he had predicted. These studies also established the period of maximum fertility of semen.

Dr. Salisbury was Head of the Department of Dairy Science from 1947 to 1969 and since then has been Director of the Experiment Station. He has also combined teaching with research and administrative duties, having received special praise for his work in organizing and teaching an undergraduate honors seminar.

FARM BUSINESS TRENDS

Some of the world's farmers have been gaining a little in the race against hunger and famine. During the past 10 years world food production apparently increased about 28 percent while population grew about 22 percent.

The adoption of improved methods seems to have accounted for about two-thirds of this increased output of food, while larger acreage has accounted for one-third. The weather has also been favorable in recent years — there have been no widespread crop failures since 1965 and 1966.

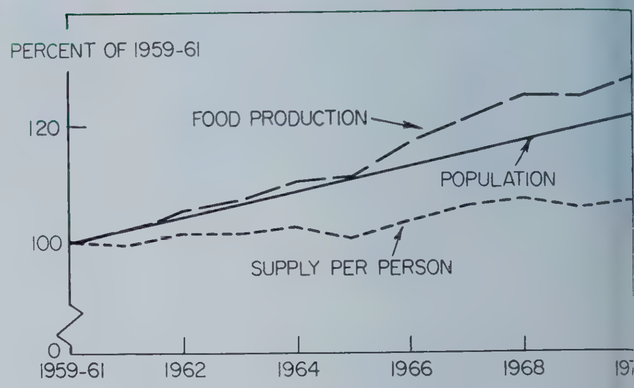
Roughly speaking, a little more than one-fourth of the earth's people live on rice, one-fourth on wheat, and nearly one-fourth on corn. The remaining fourth enjoy a varied diet including substantial amounts of meat and other animal products.

Rice output has gained about 23 percent in 10 years, slightly more than the 21 percent gain in population. The rate of gain has been quite steady, except for 1965 and 1966, when yields were very poor in India, largely because of drouth.

World wheat production gained about 30 percent during the 1960's. Most of the gain in wheat output was recorded in 1966-1968. Production in 1969 and 1970 was about 5 percent short of the record set in 1968.

Corn production increased about 30 percent during the 1960's, but dropped 2 percent in 1970, largely because of low yields in the United States.

World production of fats and oils (butter, lard, soybean oil, sunflower oil, etc.) increased about 33 percent during the past 10 years. Biggest gainer was soybean oil.



World population, food production, and food per person.

According to estimates by the United Nations, foc production per person has increased most in Euroj and Russia, and least in Africa and Latin Americ Estimates of increases for major regions of the ear during the 10 years ending with 1968 are as follows:

Region	Pct. Increase
Eastern Europe and Russia	24
Western Europe	22
United States and Canada	8
Asia (Except Russia)	4
Africa	2
Latin America	0

U.S. farmers produce food for only about 6 perce of the world's population. Less than 6 percent of t earth's inhabitants live in the United States. Wh large amounts of food and food-producing materi are exported, these shipments are largely offset by i ports of meats, sugar, coffee, and other edible produc
—*L. H. Simerl, Professor of Agricultural Econom*

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Purchases made at beef-performance-tested bull sales indicate the kind of bull that Illinois cattlemen prefer (page 15).

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE Volume 13, Number 3

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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Margery E. Suhre . . . . Editor, ILLINOIS RESEARCH

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TWO DEPARTMENT HEADS TO RETIRE

THE COLLEGE of Agriculture will lose two distinguished depa ment heads on September 1 with the retirement of Janice Smith of Home Economics and Reid T. Milner of Food Science

A native of Illinois, Dr. Smith attended the University of Illin where she received her B.S. and M.S. degrees in home econom and her Ph.D. degree in biochemistry. In 1937 she joined the s of Pennsylvania State University, remaining there until 1943. A a year as nutritionist with the War Food Administration, she turned to the University of Illinois in 1944 as professor of nutrit and head of the foods and nutrition division. In 1950 she beca head of the Department of Home Economics.

Dr. Smith has served as consultant on nutrition for the Natio Research Council, the Grocery Manufacturers of America, the nois Welfare Association, and several nutrition publications. was also appointed by President Johnson to serve on the Natio Advisory Commission on Food and Fiber.

Dr. Milner, also born in Illinois, received his B.S. and M.S. grees from the University of Illinois and his Ph.D. degree from University of California. From 1936 to 1941 he was on the s of the U.S. Regional Soybean Products Laboratory at Urba first as principal chemist and then as director. Among his acc plishments at this laboratory was the organization of analyt methods for selecting high oil soybeans.

In 1941 he went to Peoria as head of the Analytical and P ical Chemistry Division of the Northern Regional Research L oratory and in 1949 was appointed director. While there, he a member of the research team that received the Lasker award developing the commercial production of penicillin; and he o nized and directed the team that developed a method for produ dextran, a blood plasma substitute.

In 1954 he returned to Urbana as head of the relatively Department of Food Technology, later the Department of F Science. Under his leadership the department became one of outstanding units of its kind in the nation.

In recognition of Dr. Milner's achievements, the Institute of F Technologists recently presented him with the 1971 Nicholas Ap Award.

Successors to Dr. Smith and Dr. Milner have not yet b chosen. — *G. W. Salisbury*

s Test Weight a Good
Aeasure of Corn Quality?

ENN E. HALL and LOWELL D. HILL

ANY FARMERS are now questioning the fairness of test weight ndards and discounts for high- isture corn.

Until recent years nobody chal- ged the value of test weight as a asure of quality. Questions arose, wever, after the practice was begun harvesting high-moisture shelled n and then drying it with heated . When high-moisture corn is sold, is often discounted twice — for isture and for test weight. Dissatis- tion was especially high in 1970, en damage due to southern corn f blight often resulted in a lower t weight.

The test weight discount in 1970 s frequently 1 cent for every pound ow 54 pounds a bushel and an litional cent for every pound below pounds per bushel. One sample corn with 26 percent moisture had est weight of 47 pounds per bushel. was thus discounted 11 cents per hel on test weight alone. Another count was added because of high isture. When the corn was dried 15 percent moisture, the test ght increased to 54 pounds per hel. This put the corn at the num- two grade level, at which the ount for test weight no longer lies.

When drying can change the test ght of corn from 47 to 54 pounds bushel, it seems that test weight uld not be used as a means of e discount and grade reduction wet shelled corn. But does drying ically cause this much change in weight, regardless of drying tem- ature, kernel damage, variety, and vest moisture? To answer this question, many corn samples have been harvested and dried under controlled conditions at the University of Illinois.

Samples for testing were obtained by either hand shelling or machine shelling with an open-concave combine. A 2-quart sample was used for each test. Before and during drying, the samples were checked for test weight in a standard weight per bushel tester (Fig. 1).

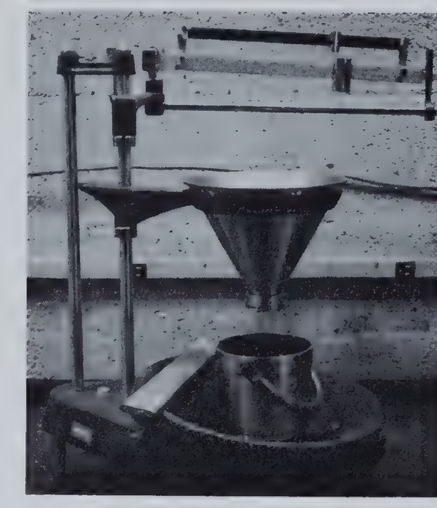
The 2-quart samples were dried in a small dryer which forced the equivalent of 135 cubic feet of air per minute through the sample. Four drying air temperatures were used: 70°, 120°, 170°, and 220° F.

Effect of drying temperature

Several different corn varieties were used in a series of tests to determine the effect of drying air temperature on test weight. Altogether, about 200 samples were dried in about 50 tests.

In general, the lower the drying temperature, the higher the test weight after drying. This is illustrated by Figure 2, which shows the effects of four drying temperatures on the test weight of a hand-shelled sample of corn designated as X-66. (This designation is a method of differentiating between samples, not a variety designation.) The highest test weight, 61 pounds per bushel, was obtained with a drying temperature of 70° F. With a drying temperature of 220° F., maximum test weight was about 2 pounds lower. This maximum was obtained at a higher moisture content — 17 or 18 percent — than when lower temperatures were used.

One explanation of the lower test weight at higher drying temperatures may be that the hot air causes "case-hardening." That is, the outer shell of the kernel hardens so that it cannot shrink as readily as it should during moisture removal.



Weight per bushel tester. (Fig. 1)

Effect of kernel damage

One series of tests was designed to determine the effect of kernel damage on test weight. Hand-shelled samples were considered to have zero damage; combine-shelled samples were damaged.

After drying to about 15 percent moisture with air at 170° F., the hand-shelled samples had a test weight about 1.5 pounds per bushel higher than that of the damaged samples. This general relationship held for all varieties and all four drying temperatures. The damage level of the combined-shelled samples would be considered low for combine-harvested corn.

Varietal effect

Figure 3 shows the test weights of several varieties after drying at 170° F. The varieties were combine-harvested during the 1970 season. Some were severely affected by southern corn leaf blight, while others were undamaged.

The results shown in Figure 3 illustrate the fact that corn from one company will not necessarily perform better than corn from another com-

in E. Hall is Assistant Professor of Agri- ral Engineering; Lowell D. Hill is Asso- Professor of Agricultural Marketing.

pany, regardless of variety designation. For example, the test weight of P-71 + 6 responded about the same as that of X-66 during drying, while P-04 was well below both X-66 and P-71 + 6. Yet P-71 + 6 and P-04 are both produced by the same company.

Effect of harvest moisture

Samples harvested at 32 percent moisture were compared with samples harvested at 23 percent moisture. All samples were dried at 170° F. The wetter samples had a test weight of 52 pounds per bushel before drying, and 59 pounds after drying. The dryer samples had an initial test weight of about 55 pounds per bushel. After drying, test weight was about 57.5 pounds per bushel, or 1.5 pounds less than that of the samples harvested at 32 percent moisture.

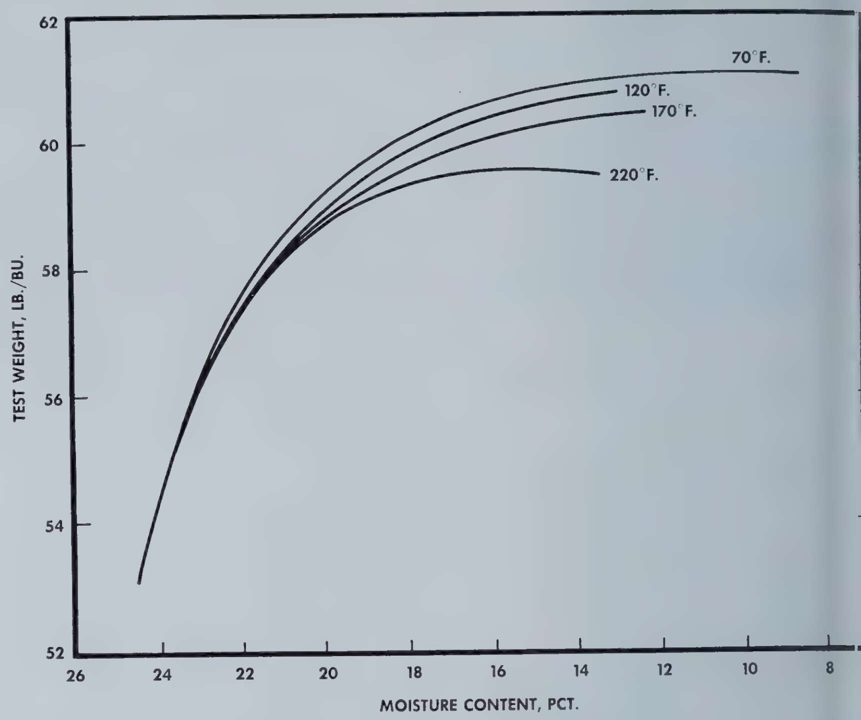
No measurement of quality

A serious weakness of test weight as a measure of corn quality was indicated by tests to determine the actual change in volume of corn kernels during drying. Test weight increased very rapidly during the initial stage of drying, thereafter leveling off. Kernel density, on the other hand, increased very gradually throughout the drying process. This indicates that the large increase in test weight during the initial drying is not necessarily related to increased kernel density.

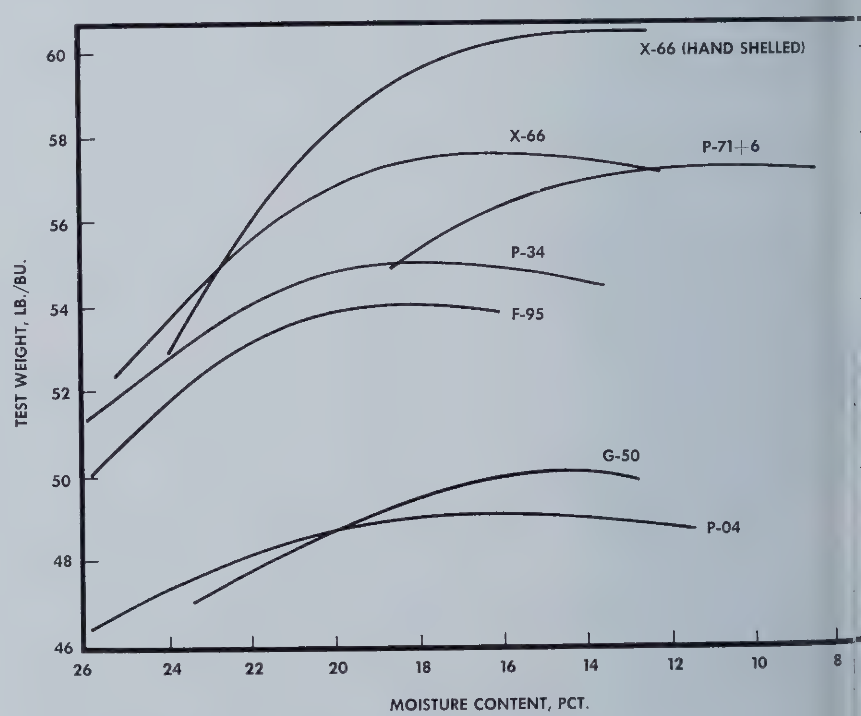
Freshly harvested, undried corn can be easily picked up by the "fist full." Much less dried corn can be held in the hand. This is due to the lower coefficient of friction in the dried corn. Because of the lower coefficient of friction, dried corn packs closer together than wet corn. Thus, the coefficient of friction alone would increase the test weight of dried corn although it obviously has nothing to do with corn quality.

Final test weight is determined by a number of things — initial moisture content, drying temperature, amount of overdrying, variety, blight resistance, and kernel damage levels, as well as by other unknown factors. Using an average test weight increase for a given initial moisture content is a very unsatisfactory way of solving the problem. One variety might increase 3 pounds per bushel, while another variety with the same initial and final moisture contents might increase 7 pounds per bushel.

If all corn samples were checked for test weight at the same dry moisture content — 15.5 percent for example — test weight might be of some value. As it is, however, test weight is a very unsatisfactory measure of corn quality.



Effect of drying temperature on test weight of hand-shelled sample X-66. (Fig.



Test weights of different varieties after drying at 170° F. (Fig.

The Thirsty Soybean

R. GHORASHY, R. L. MONROE, and J. W. PENDLETON

)N A HOT DAY in July or August, the top leaves of soybean plants ill start looking droopy about 2 clock in the afternoon. According several recent experiments at the gronomy Farm, the thirst indicated the drooping leaves may well be e primary factor limiting yields.

The first experiment was set up to etermine at what leaf moisture (leaf ater potential) the photosynthesis soybean leaves starts to decline. We iose photosynthesis as the yardstick cause this is the process whereby e soybean crop traps the sun's ergy and combines it with carbon oxide and water to produce the gars necessary for growth and delopment. The rate at which the ybean crop converts the solar engy to chemical energy determines e final crop yield.

The experiment was conducted with plants of the Clark variety during the pod-filling stage. Early in the morning, several plants were cut at the soil surface, tied upright to a metal rod, and allowed to dry out during the day. At periodic intervals, a fully developed leaf was inserted into a portable chamber to measure apparent photosynthesis (Fig. 2).

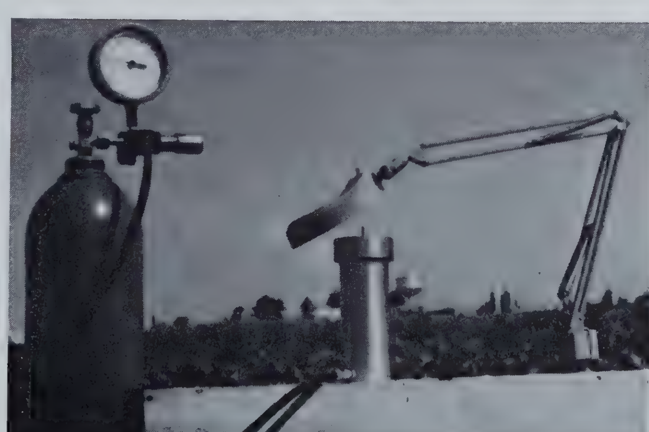
Immediately afterwards, the leaf was cut and its water status was determined. To do this, the leaf was placed inside a pressure chamber with the petiole sticking out, the chamber was sealed, and the pressure inside the chamber was increased by forcing compressed air into the chamber through a regulating valve. Pressure was increased until water exuded uniformly from the xylem vessels at the cut end of the leaf petiole. The

A thirsty soybean leaf. (Fig. 1)

amount of pressure required for exudation indicated the moisture status (water potential) of the leaf. A moist leaf requires little pressure but a dry leaf requires great pressure to force the water out of the leaf tissue.

As shown in Figure 4, the photosynthetic rate of the soybean leaves started to decline at leaf moistures of −11 to −12 bars. (A bar is a unit that measures the force holding the water in the plant tissue; the larger the negative numbers at the bottom of Figure 4, the more tightly the water is being held in the tissue.) At moistures of about −14 to −15 bars, the photosynthetic rate was only 50 percent that of fully turgid leaves.

af chamber used to asure apparent phoynthesis of an inidual leaf. (Fig. 2)



ssure chamber apatus for measuring f moisture. The gnifying lens is for erving the cut sure of the petiole and ermining when the ter is being unimly exuded from xylem vessels at end of the petiole. (Fig. 3)

A second experiment was conducted to find out how often during a day the leaf moisture of the soybean crop drops below the critical level of −11 to −12 bars. For this purpose the leaf moisture of the top, fully expanded leaves of Clark soybeans at the pod-filling stage was determined every 15 minutes for five days during early August. We also measured the solar energy received per unit of area per unit of time (langleys per minute). During the five days, maximum daily temperatures ranged from 86° to 90° F. Soil moisture was about 78 percent of field capacity.

Leaf moisture was below the critical level for maximum rate of photosynthesis every day from 10 a.m. to 6 p.m. Leaf moisture declined in direct proportion to increased solar

S. R. Ghorashy was formerly Research Assistant and R. L. Monroe is Research Assistant in Agronomy; J. W. Pendleton was formerly Professor of Crop Production and Soil Fertility.

Effect of Tillage System on Soil Tests for Acidity, Phosphorus, and Potassium

J. C. SIEMENS,
W. M. WALKER,
and T. R. PECK

IN MANY new tillage systems, such tools as the chisel plow, disk and field cultivator are being substituted for the moldboard plow. Since these tools do not completely incorporate the residues from the previous crop, they leave the soil surface in a good condition for erosion control. Another advantage is that they do not require as much time and power as does use of the moldboard plow.

However, these tillage systems may cause some problems. The fertility pattern of the soil may change, for example, becoming unsatisfactory for high yields. And it may be necessary to sample and test the soil differently than if the moldboard plow is used.

An investigation of these potential problems was begun in 1966 on the Agricultural Engineering Research Farm at Urbana. That year all plots in the experiment received 2 tons of agricultural limestone, after which they were moldboard-plowed and planted to soybeans.

Corn has been grown on all plots since 1967. The five tillage methods listed in Table 1 have been used in three replications. In 1967 and 1968 all plots received a band application of 17 pounds per acre of nitrogen; 29.5 pounds of phosphorus (67 pounds of P_2O_5); and 15 pounds of potassium (67 pounds of K_2O_5) at planting. In 1969, the same amount of fertilizer was applied broadcast before planting. Anhydrous ammonia at 200 pounds per acre was applied in June of every year.

Soil samples were obtained from every plot in 1969. Two sampling techniques were used: (1) A cc was taken from the soil surface to depth of 9 inches. (2) Samples we taken at each of three depths — 0 3-6, and 6-9 inches. All samples we analyzed for soil acidity (pH), ph phorus, and potassium.

J. C. Siemens is Associate Professor of Agricultural Engineering; W. M. Walker, Associate Professor of Biometry and Data Processing; T. R. Peck, Associate Professor of Soil Chemistry.

Yields and test results

Yields from all treatments we fairly high (Table 1). Plots receivi

Table 1. — Tillage Treatments an Corn Yields, 1968 and 1969

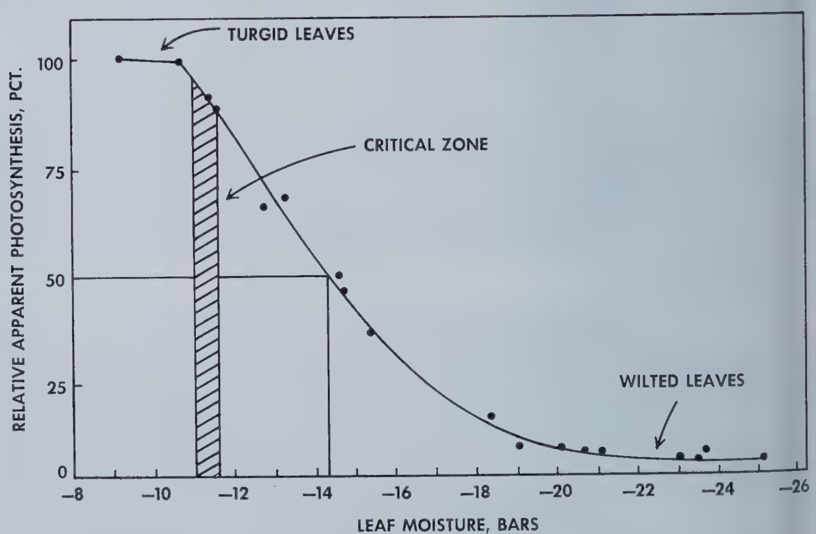
Tillage treatment	Yield, bu./A.	
	1968	196
Disk, moldboard-plow, cultivate, harrow, plant . . .	143	135
Disk, chisel, cultivate, plant . . .	146	123
Disk twice, harrow-till, plant . .	140	134
Rotary-till twice, plant	134	139
Chop stalks, till, plant	139	137

The Thirsty Soybean (Concluded)

radiation. We also measured the leaf moisture of the top leaves of an irrigated soybean plant on a day when the temperature reached 92° F. These leaves were under invisible moisture stress from 1 to 3 p.m.

The last objective was to find out whether all leaves of the soybean plant lacked moisture, or only the top ones. Moisture of leaves at 10, 20, and 30 inches above the soil surface were determined for several days in August.

The lowest leaves had enough moisture (about — 8 bars) for efficient photosynthesis. Under normal canopy conditions, however, these leaves do not get enough light for high photosynthetic efficiency. Leaves at the 20- and 30-inch heights had moisture levels below the critical values for highly efficient photosynthesis.



Relationship between apparent photosynthesis and leaf moisture. (Fig. 4)

Seemingly soybean roots cannot absorb enough soil moisture to meet the water demand of the leaves during the middle of hot summer days. Fundamental studies are nee to determine why this is t and whether the condition can corrected.

ıble 2. — Average Soil Test Values, 0-9 Inch Depth, 1969

lage treatment	pH	P	K
		lb. per A.	
ık, moldboard-plow, cultivate, harrow, plant . . .	5.8	52	298
ık, chisel, cultivate, plant . .	5.7	62	314
ık twice, harrow-till, plant	5.7	63	296
tary-till twice, plant	5.8	60	282
op stalks, till, plant	5.5	45	272

Table 3. — Average Soil Test Values for Samples Taken at Three Depths, 1969

Tillage treatment	0–3 inches			3–6 inches			6–9 inches		
	pH	P	K	pH	P	K	pH	P	K
		lb. per A.			lb. per A.			lb. per A.	
Disk, moldboard-plow, cultivate, harrow, plant	5.67	58.2	340	5.57	58.8	298	5.43	42.8	277
Disk, chisel, cultivate, plant . . .	6.10	104.0	487	5.48	52.2	262	5.23	37.8	246
Disk twice, harrow-till, plant . .	5.92	59.7	332	5.30	36.2	218	5.10	31.3	201
Rotary-till twice, plant	5.98	70.2	366	5.68	50.2	254	5.30	29.5	210
Chop stalks, till, plant	6.00	71.7	425	5.25	37.5	216	5.07	29.5	204

e disk-chisel-cultivate-plant treatent yielded significantly less than oldboard-plowed plots in 1969. This as the only significant yield differce between the moldboard-plowed ots and the other plots.

Total soil fertility was essentially e same on all plots, as indicated by e soil tests of samples taken to a pth of 9 inches (Table 2). Hower, the moldboard-plowed plots re more uniform with depth than e others (Table 3, Figs. 1 and 2).

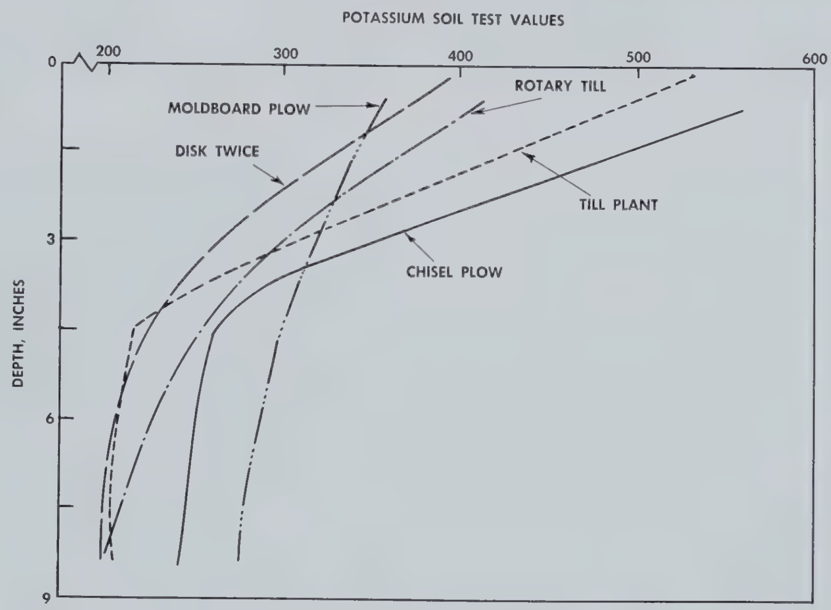
The highest fertility values at the 3 inch depth were on the chiselowed plots. The differences beeen these values and the values on e moldboard-plowed plots were ge enough to be significant.

The rapid decline in test values th depth on all plots except the ldboard-plowed ones indicates that e nutrients did not move vertily through the soil. Since the opting depth of the chisel plow was nches, a better mixing of fertilizer oughout the top 9 inches might ve been expected. However, trends soil test values for the other treatnts were not greatly different from at we would normally anticipate.

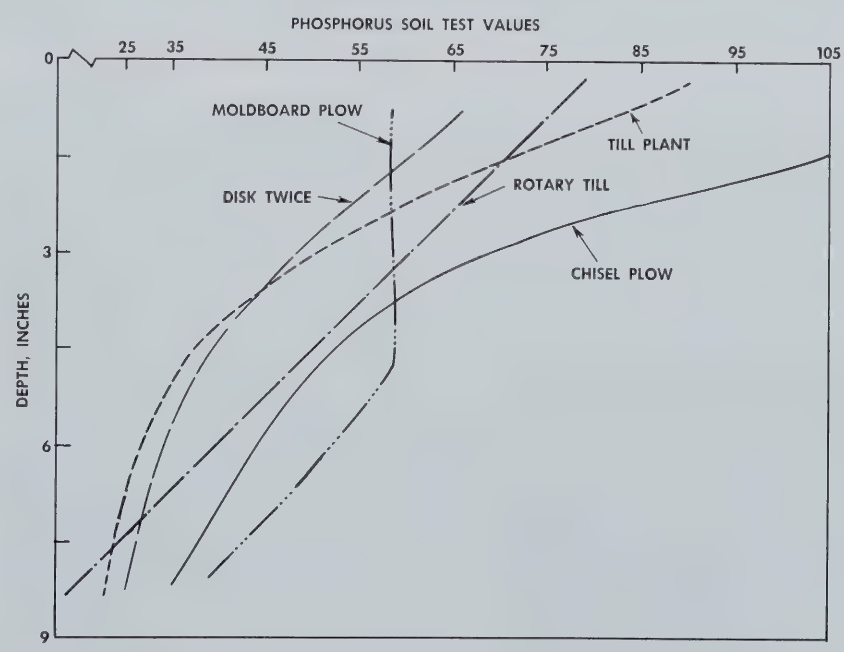
ggestions

If the new tillage systems are used, samples should be taken to plow pth and thoroughly mixed before y are analyzed. This is necessary insure a correct appraisal of the d's fertility.

Moldboard-plowing and subsent mixing of the soil to plow th may be necessary for high corn ds in years when the surface soil is remely dry and plants are obtain the majority of their phosphorus potassium from lower depths.



Potassium test values at various depths for different tillage systems. (Fig. 1)



Phosphorus test values at various depths for different tillage systems. (Fig. 2)

Harvesting Soybeans With Fewer Losses

W. R. NAVE and R. R. YOERGER

SOYBEANS have become the top cash crop in the United States. During the past three years, annual production has been more than a billion bushels. The crop is grown on over 40 million acres in some 30 states.

Despite the importance of soybeans, they are still planted and harvested with equipment designed for other crops. Since soybeans differ physically from other major crops, use of such equipment often causes excessive field losses.

When present-day combines are used for soybeans, harvesting losses are generally over 9 percent of the total crop yield. Reduction of these losses to even 4 percent would result in savings of $125 million for soybean farmers.

The grain combine harvester was first used for soybeans in the mid-twenties and has been a major factor in the expansion of soybean production. However, little progress has been made in reducing soybean harvest losses from combines (Table 1).

Cooperative research project

In 1968 a research project was initiated to analyze soybean harvesting losses and try to improve harvesting techniques and equipment. The project is being conducted cooperatively by the Agricultural Research Service, U.S. Department of Agriculture, and the Agricultural Engineering Department, University of Illinois. In the study field losses were collected in the following categories:

Preharvest loss — beans detached from stalks and lying on the ground before harvest.

Header loss — including (1) shattering loss, beans free of pods or in pods free of stalks; (3) stubble loss, beans remaining in pods attached to the stubble; (3) lodged loss, beans remaining in pods attached to stalks which were not cut or were cut at heights greater than the stubble; and (4) stalk loss, beans remaining in pods attached to stalks which were cut but not delivered into the harvester.

Threshing loss — unthreshed beans remaining in pods which passed through the harvester.

Separating loss — beans free of pods which passed through the harvester.

Effect of weeds

In 1968 and 1969, yields were reduced 25 percent by an infestation of one smooth pigweed per foot in 30-inch rows. The same degree of giant foxtail infestation reduced yields 13 percent.

When pigweed-infested plots were harvested before the weeds were dry, threshing losses were tremendously increased at normal harvesting speeds. Threshing and separating loss was 4.4 percent at 3 miles per hour, as compared with 0.7 percent at 1 mile per hour. In plots harvested after the pigweeds were dry, the threshing and separating loss was about 1 percent at both speeds.

Population and row spacing

In 1969 and 1970 populations of 60,000 to 185,000 plants per acre were grown in 15- and 30-inch rows. Some of the 30-inch rows were cultivated; others were not. No significant

Table 1. — Field Losses From Combine Harvesting of Soybeans

Type of loss	Ill., 1927	Ohio, 1957–1960	Ill., 1968
	pct.	pct.	pct.
Header loss	9.8	10.5	8.9
Threshing and separating loss	1.8	1.2	0.3
Total	11.6	11.7	9.2

Table 2. — Stubble Height From Three Headers

Variety	Stubble height, inches		
	Standard header	Floating cutter-bar	Bea buck
Hark	3.4	3.1	2.
Corsoy	3.5	3.0	3.
Wayne	4.5	2.1	..
Average	3.8	2.7	2.

differences in yield could be attr uted to plant population, row wid or presence or absence of cultivati

Lodging was considerably less plots that were cultivated than those that were not cultivated. Al lodging was less with low populati than with high populations, and v somewhat less in 30-inch rows than 15-inch rows. However, decreases lodging were not reflected in creased yields or reduced harv losses.

Stalk losses were significan higher in 30-inch row plots with c tivation than in either the 30-inch 15-inch row plots without cultivati

Air-conveyor header design

High-speed photography was u to help determine the causes of fi losses. Two major causes were four (1) shatter loss due to the agg siveness of the cross auger on combine feed table and (2) excess stubble height caused by the cut bar operating at heights greater t 2 inches above the ground.

An experimental air-conve header was built in 1969 in an tempt to reduce the field losses. conventional grain platform modified by moving the cutter forward 2 feet and providing a b of air over the grain platform dire behind the cutterbar to deliver cut material back to the cross au (Fig. 1).

In field tests, this unit satisfacto delivered material to the comb

W. R. Nave is Agricultural Engineer, AERD, ARS, U.S. Department of Agriculture; R. R. Yoerger is Professor of Agricultural Engineering.

ble 3. — *Loss From Three Headers*[a]

e of loss	Loss, pct. of total yield		
	Stan-dard header	Floating cutter-bar	Bean buckets
itter..........	6.0	5.2	4.2
bble..........	3.8	1.5	1.8
ge...........	0.3	0.5	1.2
lk............	2.6	3.0	2.7
otal.........	12.7	10.1	9.9

[a] Harvest moisture was 12 percent.

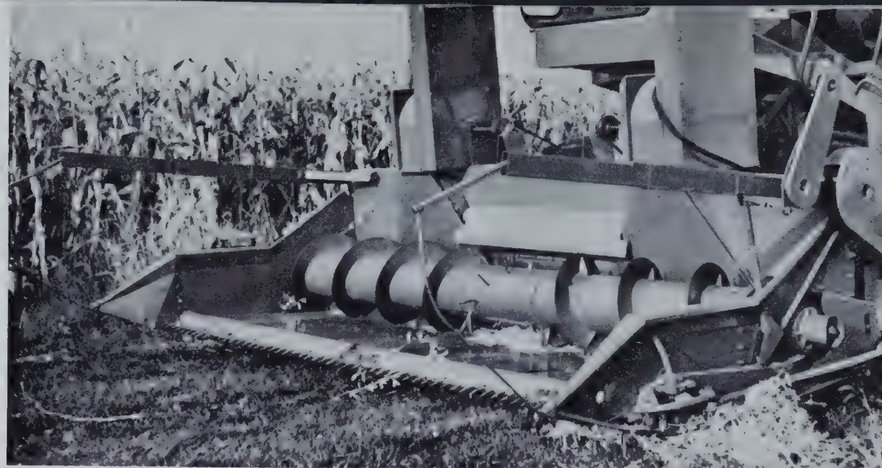
ger. However, harvest losses were t significantly reduced. The plat-m was still rigid and therefore did t reduce stubble height. Some shat-ed beans were saved from being own forward from the cross auger, t total shatter loss was not reduced cause an obstruction was present t back of the cutterbar where the was released.

ader comparison

In 1970 a standard combine header s compared with two headers iipped with different attachments reducing stubble height. The units ted were a standard 15-foot grain tform with spring float attach-nt and skid plates; a header iipped with a floating cutterbar achment (Fig. 2); and a header h a floating row crop attachment, bean buckets (Fig. 3).

These three units were tested in ee varieties of soybeans: Hark, rsoy, and Wayne. In every test the dified headers produced a shorter bble than the standard header. e lower stubble height significantly uced total losses in two of the va-ies. Another possible advantage of se attachments is that the cutting ice is moved forward, providing extended platform that should re-e the shatter loss caused by the ss auger.

The air-conveyor header design modified in 1970: The cutterbar ension was reduced to 18 inches a modified floating cutterbar unit added to improve flotation of the erbar unit. Preliminary tests indi-e even greater reductions in har-loss than with either of the other modified headers tested.



An experimental air-conveyor header which delivers shattered beans to the cross auger with a blast of air. The cutterbar is moved forward 24 inches. Air, which is provided by a pair of fans mounted just above the cross auger, travels through a false bottom to the air outlet just behind the cutterbar. The pick-up reel mounts on the two arms as on a conventional header. (Fig. 2)

A floating cutterbar attachment reduces stubble height. The cutterbar is moved forward and follows the ground contour. (Fig. 2)

A floating row-crop attachment (bean buckets) provides a low stubble height by individual row flotation. Each unit is 15 inches wide and has an extended cutterbar. Rows spaced as close as 15 inches can be harvested. (Fig. 3)

Nonprotein Nitrogen in Ruminant Rations

JIMMY H. CLARK

ALMOST a century ago, researchers observed that ruminant animals have the unique ability to convert nonprotein nitrogen (NPN) into protein. In the early 1940's, U.S. workers further demonstrated that ruminants can utilize NPN for growth.

Since the 1940's research efforts have been directed toward finding the most practical conditions for efficient NPN utilization. According to current research results, NPN can be substituted for as much as one-third of the total protein in sheep and cattle rations. Animal performance is often lowered, however, and problem areas exist.

NPN compounds

Urea is the most widely used source of NPN in practical ruminant rations. More than 300,000 tons of urea were fed in the United States last year, and its use is increasing by about 30,000 tons annually. Average yearly consumption is equivalent to about 20 percent of the high-protein plant meal fed to ruminants. The main reason for feeding urea or other NPN compunds is that they are cheaper than plant protein sources.

Other NPN compounds that have been investigated for use in ruminant rations include ammonium salts of organic acids and amides, ammoniated products, nitrogen-phosphorus compounds, and other inorganic nitrogen compounds. So far, none of these compounds has shown any significant feeding advantage when compared to urea. However, research with most of them has not been extensive.

Biuret probably has received more research attention than any other NPN compound except urea. Results from biuret studies have been conflicting. However, it may be possible to use biuret in maintenance rations, since ammonia is released from biuret more slowly than from urea. Feeding programs combining poor quality roughage and biuret support this hypothesis. A combination of biuret and urea also may offer advantages in formulating ruminant rations.

Workers at Michigan State University have reported that animals fed Pro-Sil (a silage additive which contains molasses, ammonia, and various minerals) performed as well as those fed urea. NPN sources other than urea may thus have a place in ruminant rations when more information is accumulated about them.

Jimmy H. Clark is Assistant Professor of Dairy Science.

Feeding recommendations

General guidelines for feeding NPN are (1) no more than one-third of the total nitrogen, (2) less than 1 percent of the dry matter, or (3) no more than 3 percent of the grain mixture. A more recent recommendation is to feed lactating cows no more than 0.4 to 0.5 gram of urea per kilogram of body weight.

Urea is normally added to corn silage at the rate of 5 kilograms per metric ton as the silage is blown into the silo. When urea is added to silage, caution should be used in adding NPN to the concentrate.

Table 1. — Concentrate Mixtures[a,b] (Trial 1)

Ingredient	Control	Low urea	High urea
	pct.	*pct.*	*pct.*
Corn..............	79.80	88.40	93.20
Soybean meal, 50%...	16.45	6.25	0.65
Urea, 45%.........	.....	1.60	2.40

[a] Crude protein (dry basis), 17%.
[b] Each ration contains: dicalcium phosphate, 2.00%; trace mineralized salt, 1.50%; Quadrex 10, A-D, 0.15%, sodium sulfate, 0.10%.

Table 2. — Average Dry Matter a[nd] Nitrogen Intake[a] (Trial 1)

Variable	Control	Low urea	High ur[ea]
Dry matter, kg./day	6.1 ± 0.20	5.9 ± 0.07	5.5 ± 0.
Crude protein, gm./day	681 ± 20	760 ± 9	759 ± 1
Urea, gm./day[b]...	....	70 ± 1	114 ± 3
Urea, gm./100 gm. D.M.[b]...	....	1.2 ± 0.01	2.1 ± 0
Crude protein from urea, %[b]	....	25.9 ± 0.21	41.8 ± 0

[a] Mean daily intake from 20 to 104 weeks of ± standard error of the mean.
[b] Values based on urea added to corn silage concentrate.

Table 3. — Body Measurements [of] Heifers[a,b] (Trial 1)

Age, wk.	Control	Low urea	High ur[ea]
	Wither height, cm.		
104	131.6 ± 0.24	129.6 ± 1.21	132.0 ±
20	94.4 ± 0.93	91.6 ± 1.60	93.6 ±
Diff.	37.2 ± 0.80	38.0 ± 1 18	38.4 ±
	Heart girth, cm.		
104	202.9 ± 2.28	195.1 ± 5.10	196.6 ±
20	117.9 ± 1.93	113.3 ± 2.21	116.8 ±
Diff.	85.0 ± 2.26	81.8 ± 5.54	79.8 ±
	Body weight, kg.		
104	546 ± 16.7	525 ± 20.8	540 ±
20	123 ± 5.0	113 ± 6.2	114 ±
Diff.	423 ± 13.9	412 ± 19.4	426 ±

[a] Mean ± standard error of the mean.
[b] No significant difference ($P < .05$) among t[reat]ments.

Long-term effects are studied

Most experiments with NPN h[ave] been conducted over rather sh[ort] periods when compared with the [life] of a dairy cow. Studies at the Uni[ver]sity of Illinois were therefore und[er]taken to determine the long-t[erm] effects of feeding urea with c[orn] silage as the only forage.

Trial 1. Holstein heifers, 12 to [...] weeks of age, were assigned to on[e of] three levels of urea (Table 1), [...] heifers to a treatment. The hei[fers] were fed individually at the rat[e of] 1.8 kilograms of concentrate mix[ture] per head per day. Heifers fed [the] control, low urea, and high urea c[on]centrates received corn silage tre[ated] with 0, 4, and 7.5 kilograms of u[rea] per metric ton of silage, respecti[vely]. The silage level was adjusted to r[...]

t least minimum growth require-
ients.

As the urea level in the ration in-
:eased, dry matter intake decreased,
ut not significantly (Table 2). Less
ude protein was consumed by heif-
s fed the control ration than by
iose offered the urea rations. Heifers
d the low urea ration consumed
out the recommended level of urea,
xpressed as a percentage of either
ry matter intake or crude protein
take. Those on the high urea ra-
on consumed more urea than is
ormally recommended.

Wither height, heart girth, and
ody weight were measured at 28-
ay intervals. Average measurements
20 weeks and 104 weeks, together
ith average increases, are shown in
able 3. No significant differences in
owth were found.

Trial 2. Experimental conditions
r a second trial involving five Hol-
ein heifers per treatment were sim-
ar to those of Trial 1. Also, a fourth
oup of four heifers was fed 454
ams of alfalfa meal in addition to
e high urea ration. Concentrate
ixtures are shown in Table 4.

All supplemental nitrogen in the
gh urea ration was supplied as urea.

able 4. — Concentrate Mixtures[a,b] (Trial 2)

redient	Control	Low urea	High urea
	pct.	pct.	pct.
n..............	73.40	88.95	93.42
bean meal, 50%...	22.85	4.88	....
a, 45%..........	.....	2.42	2.83

Crude protein (dry basis): Control, 20.5%; low
, 19.5%; high urea, 18.5.
Each ration contains: dicalcium phosphate,
%; trace mineralized salt, 1.50%; Quadrex 10,
, 0.15%; sodium sulfate, 0.10%.

Table 6. — Body Measurements of Heifers[a,b] (Trial 2)

Age, wk.	Control	Low urea	High urea	High urea plus alfalfa meal
Wither height, cm.				
104........................	134.2±1.36	132.2±1.93	132.0±1.00	133.8±0.95
20........................	95.2±1.98	94.4±1.17	95.0±1.10	93.0±2.42
Diff........................	39.0±1.87	37.8±1.83	37.0±1.92	40.8±2.29
Heart girth, cm.				
104........................	191.5±2.46	192.8±0.84	189.9±2.41	192.1±1.74
20........................	117.3±3.27	116.8±2.37	117.3±1.69	115.6±2.37
Diff........................	74.2±4.27	76.0±2.28	72.6±2.97	76.5±2.55
Body weight, kg.				
104........................	520±19.9	529±11.6	529±22.8	549±15.8
20........................	125±8.2	123±7.3	130±5.2	117±8.3
Diff........................	395±22.3	406±6.5	399±25.1	432±16.0

[a] Mean ± standard error of the mean.
[b] No significant difference ($P < .05$) among treatments.

Crude protein levels in the concentrates were adjusted to partially correct for the urea in the corn silage. However, heifers were not offered enough concentrate to make the total nitrogen intake equal for all rations.

No significant differences were observed in average daily intake of dry matter (Table 5). Consumption of crude protein was similar to that in Trial 1, being somewhat higher for animals fed the urea rations than for animals fed the control ration. Heifers fed alfalfa meal in addition to the high urea ration consumed less urea than those offered the high urea ration, but more than those fed the low urea ration. No significant differences were noted in average increases of body measurements (Table 6).

All rations acceptable

All rations in both trials were nutritionally adequate. Although heifers fed the urea rations consumed more nitrogen than the control animals, they grew no faster. These heifers either consumed more nitrogen than was needed for growth, or did not efficiently utilize the urea at the levels of crude protein consumed (or both reasons may apply).

In both trials, heifers on all treatments grew at a rate considered normal for Holstein dairy herd replacements. The heifers looked good, and at no time could the animals on the various rations be distinguished by their appearance.

Results indicate that all the rations are acceptable for growing dairy heifers and that the cost of rations would determine which to feed.

Continuing research

Greater use of NPN in ruminant feeding seems inevitable, as world population is growing faster than food supply, and protein deficiencies are becoming critical. The ideal in ruminant nutrition would be to meet the animals' nitrogen and energy requirements by feeding NPN with forages or waste products. However, a more complete understanding of nitrogen and energy nutrition is needed before this can be done.

In line with this need, the Dairy Science Department is studying limiting amino acids and rumen by-pass of proteins to the abomasum of ruminants. At the same time research on the long-term effects of feeding NPN is continuing with lactating cows.

Table 5. — Average Dry Matter and Nitrogen Intake[a] (Trial 2)

Variable	Control	Low urea	High urea	High urea plus alfalfa meal
matter, kg./day................	5.7±0.13	6.1±0.14	5.8±0.22	6.0±0.26
de protein, gm./day.............	673±10.5	812±20.0	823±28.7	875±36.3
a, gm./day[b]	....	83±3.3	126±2.9	119±5.15
a, gm./100 gm. D.M.[b]...........	....	1.3±0.02	2.2±0.02	2.0±0.00
de protein from urea, %[b].........	....	28.5±0.15	42.5±0.45	38.0±0.15

[a] Mean daily intake from 20 to 104 weeks of age ± standard error of the mean.
[b] Values based on urea added to corn silage and concentrate.

Nutrition and Pregnancy

Work with pigs helps determine calorie and protein needs of pregnant women

D. H. BAKER

ALTHOUGH the infant mortality rate in the United States reached a record low of 22.4 per 1,000 live births in 1967, it is still much higher than the rate in many other countries. And for every 100,000 live births in the United States, 28 women die as the result of pregnancy.

Two causes of poor pregnancy outcome stand out above all others — poor nutrition and youth of the mother. In the United States, where it has been estimated that more child marriages occur than in any other nation of the world, these two causes are interrelated, for the younger the mother, the greater the frequency of improper nutrition during pregnancy.

To learn more about the effects of inadequate diet during pregnancy, particularly when the mother is young, the Department of Animal Science has been conducting experiments with young gilts for the past five years. Although results with pigs cannot be directly applied to humans, they can provide information on the basic principles of nutrition during pregnancy.

Protein and calorie restrictions

Pregnant gilts (8 months of age) have a remarkable capacity to protect their offspring against a protein or amino acid deficit. A gilt's diet can be severely restricted in protein or in a single amino acid without affecting the number or weight of offspring at birth.

However, the effects of a low-protein gestation diet will show up at weaning, 3 weeks after birth. The number and weight of offspring will be reduced, even if the dam is fed plenty of a high-protein diet during lactation. Thus, while the dam can deplete her own tissue proteins to meet the needs of the developing fetuses, her subsequent milk production is irreversibly lowered by protein deficiency during pregnancy.

A gilt's capacity to defend her young against a protein deficiency during gestation does not extend to a calorie deficiency. A low-calorie diet during pregnancy markedly reduces both birth weight and weaning weight of offspring. Severe calorie restriction (one-third of ad libitum) will cause the gilt to lose weight during pregnancy and will also reduce her ability to maintain pregnancy. This effect is probably manifested through some sort of interference with embryo implantation in the uterus (which occurs at the sixteenth to twentieth day of gestation in the pig).

Age of dam

It is logical to assume that inadequate nutrition during pregnancy would affect a young gilt more ser ously than it would an older gilt sow. This assumption has been born out by experiments comparing month-old gilts with 13-month-ol sows. The results indicate qui clearly that the older animal, havir a lower requirement for matern growth, can tolerate undernutritic during pregnancy far better than ca the younger, less mature animal. T illustrate this point: Offspring fro protein-restricted sows weigh more birth and weaning and gain fast while suckling than do offspring gilts on an unrestricted diet.

Stage of pregnancy

Another phase of our work w directed toward ascertaining whi portion of pregnancy is most critic for adequate protein nutrition. F this study we used two diets: a lo protein fortified corn diet which ha previously been found inadequa for supporting maximum weight offspring; and a high-protein for fied corn-soy diet. Four lots of gi were fed as follows: (1) low-prote diet throughout pregnancy; (2) hig protein diet during first third of pre nancy, low-protein diet during la two-thirds; (3) low-protein diet du ing first two-thirds of pregnancy, hig protein during last third; (4) hig protein diet throughout pregnancy.

Fetal growth is most rapid duri the last third of pregnancy. Prot restriction during this period v clearly more harmful to subsequ lactation performance of the dam, indicated by weaning weight of pr

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Effects of Protein Restriction in Young Gilts During Varying Portions of Gestati

	Diet fed[a]			
Gestation period				
0– 40 days	Corn	Corn-soy	Corn	Corn-s
40– 80 days	Corn	Corn	Corn	Corn-
80–114 days	Corn	Corn	Corn-soy	Corn-
Number of litters	17	16	14	19
Live pigs per litter	7.4	7.0	8.0	8.
Pigs weaned per litter	6.3	6.1	7.6	7.
Litter weight at birth, kg.	9.5	9.0	9.8	10.
Litter weight at weaning, kg.	25.1	25.7	35.7	31.
Maternal gestation gain, kg.	25.8	26.7	36.3	35.
Maternal lactation gain, kg.	−1.6	−0.9	−8.6	−9.
Lactation diet intake, kg.[b]	65.2	63.3	67.4	67.

[a] The corn diet, fortified with vitamins and minerals, contained 8.7 percent protein; the corn-soy also fortified, contained 16.0 percent protein. Diets were fed at the rate of 1.9 kilograms per head per throughout pregnancy.
[b] The corn-soy diet was fed ad libitum to all gilts during a 3-week lactation period.

y, than restriction during the first middle third (see table). When lts were fed the protein-adequate et throughout gestation or during e last third of gestation, they ap-rently transferred their weight gain vantage to their offspring through creased milk yield.

plication to the human

When extrapolated to humans, our rk with pigs would suggest that alnutrition during pregnancy could ve strikingly different results de-nding on whether the new-born by is breast-fed or bottle-fed.

A low weight gain during preg-ncy as the result of calorie restric-n will lower birth weight of the spring. There is little question that s occurs in both pigs and humans. hile the consequences of lowered th weight are uncertain, an in-asing body of evidence suggests a gher mortality rate during early , lowered growth rate, and perhaps n impaired learning ability. These tential problems could be mag-ied in a breast-fed baby, since the dence with pigs suggests that mal-trition during pregnancy affects lk quantity and quality.

Protein restriction during preg-ncy seldom reduces the birth ight of the offspring, at least in the , although it does impair subse-ent lactation of the dam. Hence, s type of restriction in the pregnant man might have the most serious sequences if the baby were breast-. Certainly pregnant women should sume liberal amounts of high-lity protein during the last third pregnancy. This is especially im-tant if a woman is under 18 and reast-feeding is planned.

he Committee on Maternal Nu-ion of the Food and Nutrition rd of the National Research ncil has seriously questioned the ular practice of dieting during gnancy. They have suggested that average pregnancy weight gain of pounds is desirable. This commit-concluded that nutrition and teen-pregnancy deserve great national ntion if we are to significantly er our rate of infant mortality.

Texture in Potato Chips

Starch contributes crispness; cell walls and pectic materials contribute tenderness

VERNON L. PORTER

WHAT CAUSES the tenderness and crispness that we all want in a potato chip? This question has become especially important to manufacturers who have been trying to simulate potato chips from a mixture of ingredients.

Several possible explanations were examined in recent experiments at the University of Illinois. As a result, we have identified some factors that do affect the texture of potato chips and some that do not.

Are cell walls broken?

One possibility was that the cellular walls in potato slices were destroyed during frying, thus affecting texture. One researcher had previously found that over half the cells were ruptured during frying in oil. Another researcher, however, had reported that the cell walls rarely, if ever, ruptured during frying. Blistering, he found, resulted from simple cell separation due to expansion of steam trapped within the slices when the surface became dehydrated and sealed.

Experiments were conducted to determine which report was correct. Several potato varieties were used. They had been grown in different states and had been stored at varying temperatures and for varying periods. Slices $\frac{1}{16}$ inch thick were fried in oil at different temperatures. The chips were then carefully de-oiled and rehydrated, and thin sections were observed under the microscope (Figs. 1 and 2).

Results showed conclusively that the cellular structure of the slices was not appreciably ruptured during the frying process, regardless of variety, storage conditions, or temperature of frying.

On the basis of these results, it was hypothesized that cell walls help to maintain a desirable texture. The contribution of the cell walls was indicated by an experiment with potato starch, described below.

Potato starch

Raw potato cells contain many starch granules. After frying, these granules become completely gelatinized within the cell — that is, they absorb moisture, swell, and lose their granular appearance to form a starchy mass.

To determine the effects of both starch granules and cell walls, an experiment was set up with potato starch (starch granules that have been broken from the potato cells to form a fine white powder). The starch was very carefully gelatinized to obtain a soft rubbery clear gel without any cell structure. This gel was cut into $\frac{1}{16}$-inch slices, which were fried in oil at different temperatures and with different cooking techniques.

After frying, the gel slices were invariably very brittle and hard. It was concluded that starch contributes brittleness or crispness to potato chips while the cell wall contributes tenderness.

Is gelatinization essential?

Further experiments were conducted to find out how the degree of gelatinization affects texture and flavor. Different degrees of gelatinization were obtained with microwave heating (Fig. 3).

Vernon L. Porter is Instructor in Food Science Extension.

It was learned that raw potato slices must contain more than 50 percent moisture for any appreciable gelatinization to occur during frying. Incomplete gelatinization resulted in mealy chips with a raw potato flavor. The less the starch was gelatinized, the greater the degree of mealiness.

Excellent texture was found in chips made of steam-blanched potato slices, which were completely gelatinized before frying. This indicated that frying in oil was not necessary for gelatinization.

Pectic materials

Several research workers have reported that pectic materials are the major adhesive substance between the cell walls of potatoes and that they play an important role in the texture of boiled potatoes. Do these substances also affect the texture of potato chips?

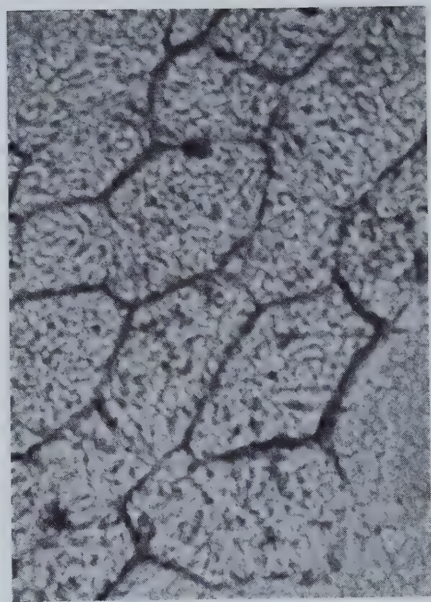
Finding the answer to this question involved the use of pectinase, an enzyme which will break down many pectic materials. Potato slices 1/16 inch thick were soaked in a solution of pectinase in a buffer for 12 hours. Another lot of similar slices was soaked in a buffer control without pectinase for the same length of time.

The pectinase-treated slices became very fragile and fell apart, while the slices soaked in the control solution remained strong. After being fried in oil, the pectinase-treated slices were much less tender than the control lot, although they were not unacceptable as a chip. After rehydration the treated slices reverted to their very fragile condition but the control slices retained their strength.

These results (1) confirmed that pectic materials are the primary adhesive materials between cell walls and (2) indicated that these materials do help to develop tenderness in potato chips.

Nitrogen-containing compounds

Since potato slices contain small amounts of protein and other nitrogen-containing compounds, it was desired to know their importance in texture development. To vary nitrogen content, one batch of 1/16-inch



Cellular walls of chips remained intact during frying, as shown by this microscopic view of a thin section. The section was embedded in carbowax to preserve structure of the cells when the section was sliced. (Fig. 1)

potato slices was soaked in distilled water for 24 hours, while others were soaked in solutions of proteolytic enzymes. Nitrogen content of the treated slices and of untreated control slices was determined by the Keldahl method, with the following results:

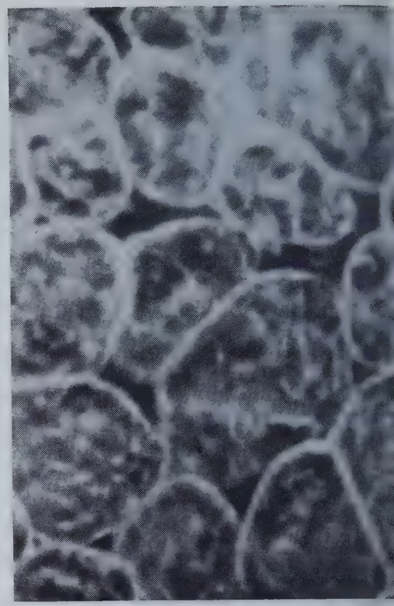
Treatment	*Pct. nitrogen*
None	1.00
Distilled water	.84
Proteolytic enzymes	.66

No differences in tenderness and crispness could be detected in the slices after frying. Thus, reducing nitrogen-related compounds by as much as one-third had no discernible effect on texture.

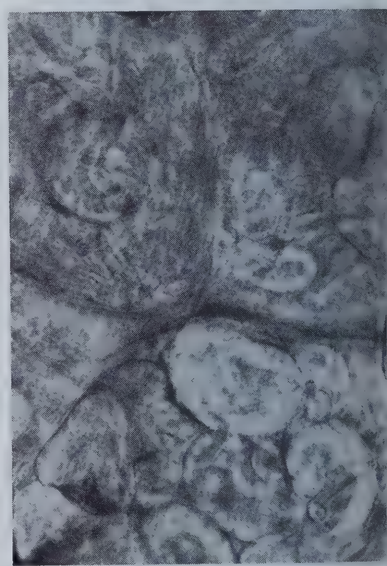
Other factors

Texture was not appreciably affected by percent of oil, although past authorities have considered this a factor. Neither was texture affected by rate of cooking.

Microwave finish drying of potato chips did affect texture, depending on the moisture content of the chips when they were removed from the oil before microwave treating. Toughness increased with increases in moisture content, but it did not become



A section that was not embedded in c bowax but was otherwise similar to t in Figure 1. Cutting has pushed the c around. (Fig.



Partially gelatinized starch granules potato cell. (Fig

undesirable until moisture con went beyond 12 or 13 percent.

If chips are not microwave- ished, moisture content should less than 3 percent when they are moved from the fryer. At mois contents above 3 to 4 percent, chips will become tough upon cool

Sealed packages of potato c stored 3 and 5 weeks did not cha in texture from their fresh condi

What Kind of Bulls Do Cattlemen Pefer?

RICHARD H. SIMMS

HE KIND of bull preferred by Illi-
- nois cattlemen can be pretty well
scribed by studying results of
inois beef-performance-tested bull
les.

Beginning in 1968, the Illinois Beef
provement Federation has spon-
red an annual all-breed auction.
rebred beef cattlemen and Exten-
n personnel in western Illinois
nned the initial sale. Now direc-
s of the sales represent commercial
ef interests and purebred cattle-
n throughout the state.

Only bulls that have been raised
Illinois and have "passed" their
formance test have been eligible.
e performance test includes (1)
5-day weaning weight, (2) 365-
y yearling weight, (3) daily gain
ween 205 and 365 days of age,
quality-grade evaluation, and
individual animal soundness.

During the first three years, 161
ls, representing six major breeds,
re consigned to the sales (Table
These animals originated from
herds in 43 counties. Of the beef
d owners who have bought bulls
the sale, about 95 percent have
n commercial producers.

Table 2 shows three-year average
ces paid for the three highest
ced and the three lowest priced
ls of the Angus, Charolais, and
lled Hereford breeds. (The other
eds were omitted because of their
ited numbers.) Every year the
iation between the highest priced
and the lowest priced trio in
h breed was rather constant at

le 1.—Number of Bulls Consigned to Auction Each Year

reed	1968	1969	1970	Total
s...........	8	14	17	39
olais.........	6	9	15	30
ford..........	4	1	1	6
d Hereford....	14	32	19	65
d Shorthorn....	2	6	0	8
horn.........	6	5	2	13
tal...........	40	67	54	161

Table 2. — Average Price per Head and Performance of Three Highest Priced and Three Lowest Priced Bulls, by Breed, 1968-1970

Breed	Price per head	205 days		365 days		Daily gain on test, lb.
		Quality[a]	Wt., lb.	Quality[a]	Wt., lb.	
Angus						
High trio................	$1,146	14.9	607	14.7	984	2.36
Low trio................	457	14.9	587	14.6	962	2.35
Charolais						
High trio................	1,469	14.3	628	14.3	1,175	3.47
Low trio................	703	13.1	603	13.7	1,055	2.83
Polled Hereford						
High trio................	1,097	14.9	656	14.7	1,074	2.55
Low trio................	456	14.8	554	14.8	946	2.33
Combined						
High trio................	1,237	14.7	630	14.6	1,078	2.79
Low trio................	539	14.3	581	14.0	988	2.50

[a] USDA quality grades. 15 = low prime; 14 = high choice; 13 = average choice.

Table 3. — Average Price per Head According to Average Daily Gain From 205 to 365 Days, 1968-1970

Daily gain, lb.	Price per head			
	Angus	Charolais	Polled Hereford	All bulls
<2.00......	$ 400	$ ...	$ 575	$ 520
2.01–2.33......	772	987	816	797
2.34–2.66......	740	841	618	649
2.67–3.00......	692	942	697	763
3.01–3.33......	1,087	1,475	678	1,032
3.34–3.66......	...	912	884	901
>3.67......	...	1,269	...	1,269

Table 4. — Average Price per Head According to Yearling Weight, 1968-1970

Yearling weight, lb.	Price per head			
	Angus	Charolais	Polled Hereford	All bulls
<950.....	$ 710	$ ...	$ 524	$ 584
951–1,000.....	796	777	620	645
1,001–1,050.....	653	890	758	768
1,051–1,100.....	843	1,037	807	948
1,101–1,150.....	...	1,112	798	884
>1,151.....	...	1,153	1,300	1,167

$650 to $750. This was a greater variation than that found between breeds.

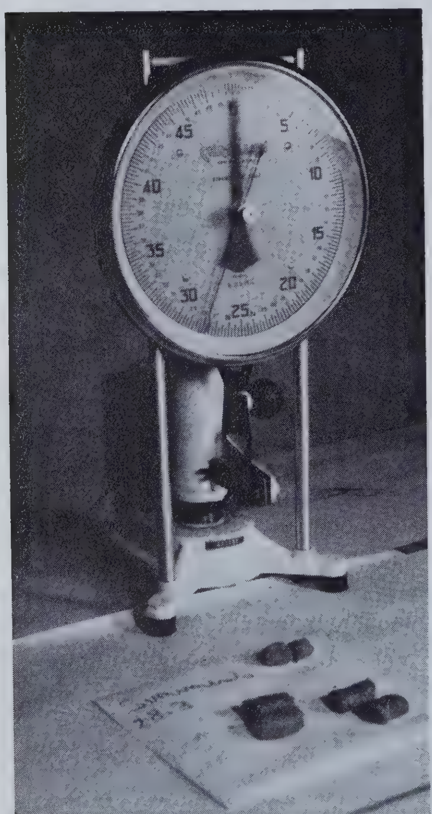
The highest priced and lowest priced trios varied only slightly in quality (Table 2). Purchasers have placed greater emphasis on weaning weight, yearling weight, and post-weaning rate of gain. The average weight differential of 49 pounds at weaning was increased to 90 pounds at 365 days of age and 185 pounds at time of sale.

The 205-day weight is primarily a measure of the cow's mothering and milking ability. An animal's average daily gain after weaning and its weight at 365 days are considered reliable measures of its inherent gaining ability. Prices for animals with different amounts of post-weaning gains are shown in Table 3; prices according to yearling weight, in Table 4. Sale value obviously improves as yearling weights increase, with cow herd owners showing a definite preference for bulls weighing 1,050 pounds or more at 365 days of age.

The number of cattlemen participating in the sales indicates that an all-breed performance-tested bull sale is needed in Illinois. The sale has also stimulated the enrolment of new herds in the beef-performance testing programs.

Richard H. Simms is Area Extension Adviser in western Illinois, specializing in livestock.

Hind quarter of an embalmed double-muscled bull with the skin dissected away. Note heaviness of thigh muscles. (Fig. 1)



Warner-Bratzler shear apparatus. Cylinder-shaped samples of muscle are placed through a hole in a guillotine-like shear plate. The motor drive shears the sample while the amount of force required is recorded on the dial. (Fig. 2)

Double Muscling in Cattle

Disadvantages must be overcome before double muscling can benefit beef industry

JAMES E. LOVELL and TIMOTHY G. LOHMAN

DOUBLE-MUSCLED cattle have larger muscles, less fat, and smaller bones than normal cattle. The rump is very rounded, and the major muscles of the hind leg are especially enlarged (Fig. 1).

Increased dressing percentage and cutability, as well as decreased fat, are obvious advantages of double muscling. Meat from double-muscled animals is also more tender than that from normal animals. However, these advantages are somewhat canceled out by the disadvantages of infertility, difficult calving, and a tendency toward arthritis and lameness.

A great deal of research is being conducted on the genetics of double muscling. It is hoped that, through selection of breeding animals, the advantages of double muscling can be used for the benefit of the beef industry without propagating the disadvantages and thus creating management problems.

At the University of Illinois, research on double muscling is being conducted cooperatively by the Departments of Veterinary Biological Structure and of Animal Science.

Carcass evaluation

Detailed carcass analysis has been completed on two pairs of animals, each pair consisting of a normal and a double-muscled animal. One pair was maintained on a low-energy ration until 10 months of age, when the animals were slaughtered and their carcasses were evaluated. The second pair was slaughtered at 18 months of age after being on a full feed of high-energy ration.

James E. Lovell is Professor of Veterinary Biological Structure; Timothy G. Lohman is Assistant Professor of Animal Science, of Veterinary Medicine, and of Physical Education.

In both pairs, the double-musc (hypertrophied) animal had higher dressing percentage and m cle percentage (Table 1). On basis of these data, double-musc animals apparently have about times as much muscle as normal a mals at the same weight. Except a very few muscles, the entire m culature tends to be enlarged.

The double-muscled animals in study had one-third to one-half much fat as normal animals, wh is in line with results obtained several other research workers. T finding could have important pr tical significance because of the la amount of excess fat (over 2 bill pounds a year) which is trimn away before beef is consumed.

As the carcasses were handled the meat was processed, other dif ences were observed. Meat from double-muscled animals was ligl in color, softer, and more like than the products from the nor animals. To measure the differe in softness, raw meat samples w tested on a Warner Bratzler sh apparatus (Fig. 2). This instrum measures the amount of force quired to shear a sample. Follov are the average shear values of

Table 1. — Carcass Data for Tw Hypertrophied and Two Normal Animals

Carcass measurement	10 months Normal	10 months Hypertrophied	18 mon Normal	Hy p
Live wt., lb.	531	547	870	8
Dressing pct.	54	58	65	
Muscle pct.	70	79	63	
Bone pct.	22	18	14	
Fat pct.	3	1	22	

twelve samples from five muscles r each animal:

	10 mo.	18 mo.
ɔrmal.	33	30
ɔuble-muscled	20	18

Resistance to shear was about 40 rcent greater in the normal sam-ɘs than in those from double-mus-ɘd animals.

icroscopic studies

Muscle specimens for microscopic ıdies were collected from the car-sses of the four animals as soon as ssible after slaughter. Additional nples were obtained by biopsy from 24-month-old double-muscled bull. l specimens were processed by ndard histological methods.

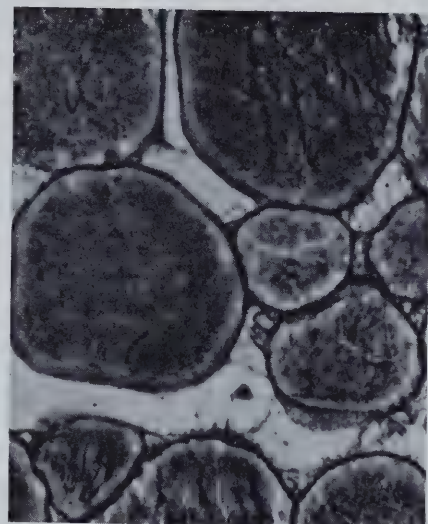
Histological preparations were ob-ved microscopically and the diam-ɘr of muscle fibers was measured th an eye piece micrometer. Table gives observations made on one of ɘ large muscles of the thigh. The ures in this table represent the ɘrages of 100 muscle fibers from ɘh animal. The variation in diam-r is indicated by Figure 3.

Average diameter of muscle fibers definitely larger in double-muscled mals than in normal ones (Table As animals grow older, there is shift of fibers from the smaller meter range to the larger range. is shift is more pronounced in ıble-muscled animals, suggesting t more fibers are growing to a ger size in these animals than in normal ones.

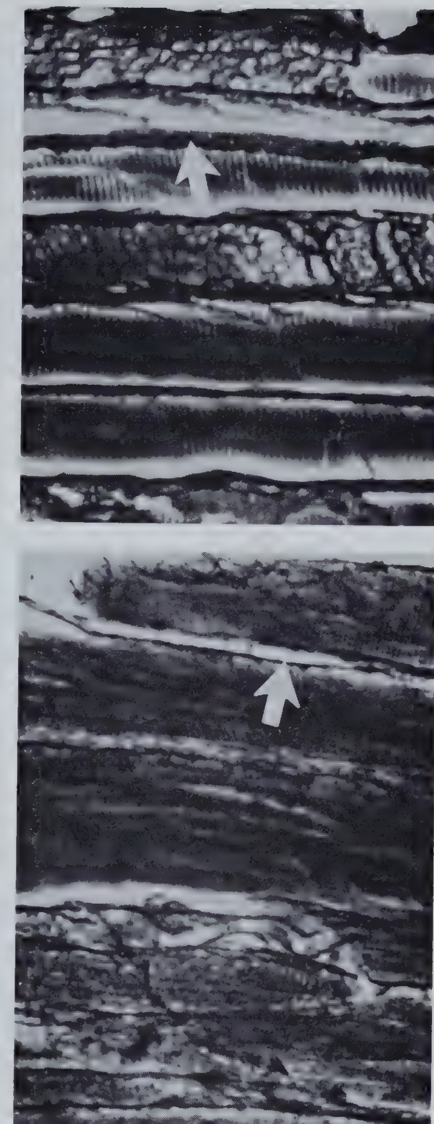
To determine the amount of con-ıtive tissue in the muscle, a special n was used that makes this tissue ɔear as dark, intensely stained ma-al between the muscle fibers (Fig. 4). Much less connective tissue was found in double-muscled animals than in normal animals. This difference in connective tissue content, together with the difference in muscle fiber size, may account for the greater tenderness of the raw meat samples from the double-muscled animals.

ıle 2. — Average Diameter of ıitendinosus Muscle Fibers, Normal and Hypertrophied Animals

ɔ of muscling and ıge of animal	Aver. diam. of muscle fibers, microns
ıal, 10 mo.	41
ɘrtrophied, 10 mo.	43
ıal, 18 mo.	46
ɘrtrophied, 18 mo.	60
ɘrtrophied, 24 mo.	63



Cross section of the biceps femoris muscle of a 10-month-old double-muscled animal, stained with Gomori silver stain. Magnification 430X. Note variation in diameter of muscle fibers. (Fig. 3)



Longitudinal sections of the biceps femoris muscle of a 10-month-old normal animal (above) and a 10-month-old double-muscled animal (below). Samples are stained with Gomori silver stain. Magnification 430X. Arrows point to examples of silver-stained connective tissue fibers. Note heavy network of these fibers between and around muscle fibers of the normal sample and the sparse network in double-muscled sample. Also, note how much larger the muscle fibers are in the double-muscled sample than in the normal one. (Fig. 4)

Chemical composition

The carcass muscle mass was separated into 43 muscle groups and each muscle was analyzed for its water, protein, and fat content. The biggest difference was in fat content, with normal animals having about 1.5 times as much fat within the muscle as the double-muscled animals. After adjustments were made for the differences in fat content, there was little difference in the amounts of water and protein.

More study needed

Further study is necessary to determine whether the increased amount and tenderness of muscle on double-muscled carcasses can be used to the advantage of the meat industry. Because of the many reproductive problems, double muscling is at present undesirable in beef production. However, industrial crossing, which is being used in Europe, presents possibilities. This involves crossing a double-muscled bull with a dairy or dual-purpose cow to produce veal calves. These calves have returned 7 percent more gross income to the breeder, but calving problems were increased by 5 to 7 percent.

The Proposed Split-up of USDA: A Critique

R. G. F. SPITZE

THE MICROPHONES had hardly been turned off after President Nixon's State of the Union message on January 22, 1971, before agricultural leaders were debating the implications. He had proposed that the U.S. Department of Agriculture, along with six other cabinet departments (Interior, Commerce, Labor, Health-Education-Welfare, Housing-Urban Development, and Transportation), be absorbed into four new departments.

Organized in 1862, the USDA has steadily expanded its programs until it now affects every citizen. Closely tied to the Department are the powerful House and Senate Agricultural Committees, some 3 million farmers, and their strong interest organizations throughout the nation.

Proposed reorganization

Since January, President Nixon has spelled out his proposal, and implementing bills have been introduced in Congress. The following list of proposed departments includes the sections into which each would be divided, as well as the units of the USDA that would probably be transferred to each new department.

The Department of Natural Resources would include divisions of land recreation resources; water resources; energy and mineral resources; oceanic, atmospheric, and earth sciences; and Indian and territorial affairs. Large groups of employees now in the Forest Service and conservation programs of the USDA would probably be transferred to this new department.

The Department of Community Development would be divided into housing; community transportation; urban and rural development; and federal insurance. Units from Agriculture could include water and waste disposal programs, Rural Electrification Administration, and rural housing.

The Department of Human Resources would include units of health; human development; and income security. Candidate programs from Agriculture are food protection, food distribution, and nutrition.

The Department of Economic Affairs would have six sections: business development; farms and labor; labor relations and standards; national transportation; social-economic-technical information; and international economics. Perhaps most of Agriculture could end up here, including the Commodity Credit Corporation, Agriculture Stabilization and Conservation Service, and most of the Statistical Reporting, Foreign Agriculture, Agricultural Research, Economic Research, Extension, and Cooperative State Research Services.

Some of the meanings

No infallible source of wisdom exists for choosing among admittedly sincere, honest proposals. Yet important issues in this proposal can be identified for the majority decision-making process.

The new departments would focus on general societal goals rather than on a specific clientele. The reorganization has the premise that all citizens are interested in natural and human resources, the community, economic affairs, and other societal concerns, and would therefore support programs in these areas. Agriculture would interact with the departments' subunits.

Existing departments were responses to problems around a particular occupation or service. For example, Agriculture was centered on farmers and the rural community; Labor, the urban working man; Commerce, urban business; and HEW, on health, education, and welfare services. Each clientele was vigilant to maintain viable programs.

Is government administration mo
likely to serve the public welfare
people's participation is closely as
ciated with their work and inter
groups? Or will the public be bet
served if participation is based
goals for society?

**The reorganization would me
some centralization and strength
ing of federal executive pow**
With the work of seven departme
compressed into four, the Wh
House staff would deal with fe
line personnel and the interest gro
would likewise confront fewer a
stronger foci of authority. The Pr
ident promises that the Secretary
each new department "would
given important managerial disc
tion that he does not always en
today." This centralization, the Pr
ident believes, would result in grea
efficiency.

Which will better serve citizens a
their many interest groups —
present agencies with their overl
ping authority, or the fewer a
stronger agencies that are be
proposed?

**Communication links between
executive and both the public a
Congress would be realigned.** R
tively clear-cut lines of commun
tion now exist between farmers a
USDA, and between the latter a
the two agricultural committees
Congress. Similar linkages exist
other groups.

If broad goals replace occupati
and services as cohesive eleme
would policy makers receive data
comparable or better quality? Wo
interest groups be better represent
Would programs be as well evalua
by interest groups, by Congress,
by the departments themselves?

Regardless of outcome, the Pr
dent's proposal should stimulate
evaluation and result in improvem
During the coming months,
policy issues will be of more inte
to rural people.

R. G. F. Spitze is Professor of Agricultural Economics.

ollege Exhibit

Vins Top Honors

the Chicago

Vorld Flower

nd Garden Show

OR THOSE who didn't get to the Chicago World Flower and Gar- Show last spring, we are showing e the three sections of the prize- ning University of Illinois exhibit. s exhibit captured the Governor's ard as the "most meritorious dis- of the entire show." It also won Garden Club of Toronto award the best use of annual plants, and ilver medal given for the most standing large exhibit by a non- fit organization.

he purposes of the exhibit were nterest visitors in gardening; to uaint them with new varieties lawn grasses, flowering annuals, vegetables; and to provide in- nation on the culture and care of lens and lawns. V. L. Brazle and . Griffith of the Office of Agricul- l Communications designed and structed the exhibit.

rinted informational materials on grasses, vegetables for minigar- , and flowering annuals were lable for visitors. If you would to receive any of these materials, e to the Publications Office, 123 nford Hall, University of Illinois, ana, Illinois 61801.

The section on flowers featured some of the 1971 All-America Selections, as well as other new offerings. G. M. Fosler, assistant professor of ornamental horticulture, managed this section, and also coordinated the entire exhibit.

New varieties of lawn grasses, examples of lawn weeds, and disease information were displayed in the turf section, which was managed by J. D. Butler, associate professor of turf extension.

"vegetables for minigardens" section red a patio setting with vegetable ties suitable for growing in small tubs, and containers. H. J. Hopen, iate professor of vegetable crops, and . Courter, associate professor of culture, were in charge of this part exhibit.

FARM BUSINESS TRENDS

THE CHARTS on this page show important trends in farming in Illinois during the 15 years from 1955 through 1969. These trends are the results of competition among agricultural enterprises for farmers' land, capital, labor, and managerial skill.

At the beginning of the period three enterprises — cash corn, hogs, and cattle — were about equal, with each contributing about 20 percent of total cash receipts from farm marketings. Soybeans ranked fourth, contributing about 12 percent. Dairy was in fifth place, turning in about 8 percent, and the wheat and poultry enterprises each provided about 5 percent.

Over the 15-year period the two strongest enterprises were cash corn and soybeans, each of which gained substantially. The major meat animal industries just about held their relative positions in the state's agricultural economy. The dairy, poultry, and wheat enterprises diminished in importance.

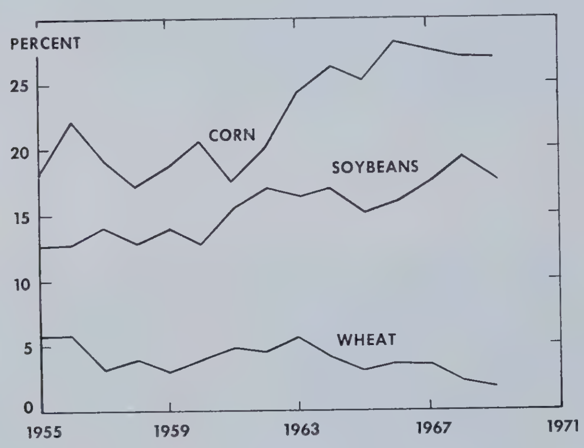
By the end of the 1960's cash corn was way out in front, contributing about 27 percent of total cash receipts from farm marketings. Sales of soybeans made the most spectacular gains, rising to around 18 percent of cash receipts from farm marketings, half again as much as at the beginning of the period.

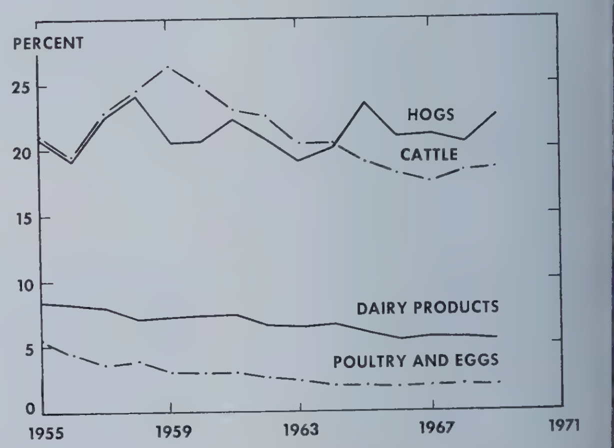
Corn and soybeans are strong in Illinois becaus the soil and climate are especially favorable for them demand for both crops is growing rapidly, and th state has low-cost transportation to the big domest markets of the East and South and to foreign port

The hog and beef cattle industries combined mai tained their comparative importance. They contribute about 40 percent of all cash receipts from farm marke ings at the end of the period, the same as at its b ginning. At the end, however, hogs appeared to be little stronger than cattle.

Many Illinois farmers dropped their dairy a poultry enterprises, although this was partly offs by expansions on other farms. Receipts from sales dairy products decreased from about 8 percent of t total to 6 percent. Receipts from sales of poultry pro ucts, mostly eggs, diminished from around 5 perce to only 2 percent.

Receipts from wheat diminished from more than percent in the mid-1950's to only 2 percent at t close of the 1960's. Wheat lost favor with Illin farmers when the government price support level w reduced to save money and encourage increased u of wheat for animal feed. — *L. H. Simerl*





Cash receipts by commodity as percentage of total cash receipts from farm marketings, Illinois, 1955-1969.

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United States Department of Agricu

Fall, 1971

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

A fisheye camera view of a new device for automatically measuring and recording variations in the soil surface (page 10).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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THE CAMPUS IN CHANGE

LONG HAIR on males and mini-skirts on girls may be the most vious, but not the most substantive changes showing up am college students in the past decade. Students are changing in t outlook, their philosophy, and their life style.

In general, students more and more feel that University rules c cerning their personal lives are confining and bureaucratic; he the big surge toward apartment living, which they feel provides in pendence. Still, the complaint increases that the student is trea merely as a number on campus. Thus the students plead for m individual attention from faculty at the same time that they dem more freedom.

Our campuses have changed from relatively apolitical cente more politicized, even polarized, communities. Students are not demanding and getting more participation in University governm but are also protesting the shortcomings they think they witnes the local, national, and international scene. The "activist" few most vocal and most wont to rush to the barricades.

Usually conservative by background, agriculture students are in the vanguard of each new protest or demand. Nor are they usu very active on the campus political scene. Their own faculty o feel that the common sense of these students should not be so m but could help serve as a much-needed balance wheel in the stu government.

Far fewer students attend campus church services than in the p yet there appears to be a burgeoning interest in a revitalized Ch tianity. In addition some students show an enormous concern for disadvantaged and try to assist them.

"More relevance in instruction" is the cry of students, particul in liberal arts. Students in agriculture, engineering, and business it easier to discern the relationship between the classroom and business world.

The College of Agriculture hopes to make its programs of s flexible enough that its graduates will not become "obsolete" as society changes. The Agricultural Science curriculum, now 24 y old, provides an especially wide latitude in course selection. Our dents have used it wisely and we believe they will continue to d For the motivation of agriculture students today is fully as st as it ever was, and society may remain confident in these y people. — *K. E. Gardner, Associate Dean*

;alt Causes Problems \long Illinois Highways

Alkaligrass may provide cover on roadsides where heavy salt use has killed vegetation

'D. BUTLER, T. D. HUGHES, G. D. SANKS, and P. R. CRAIG

In background, the soil of this eroded and silted median is being prepared for seeding with alkaligrass. (Fig. 1)

'ALT DAMAGE to soil and vegetation has become serious along Illinois ghways, especially the Interstate 'stem in Cook County.

This problem is relatively new in e state. Although salt often limits ant production in arid regions, it ›es not normally cause trouble in ımid areas like Illinois. Until very cently almost the only difficulties ıe to salt have been occasional slick ots in field soils and overflow of salt ıter from oil wells. This has been anged, however, as the need to :eedily move more and more people the highways has greatly increased e use of salt (sodium chloride) for ow and ice removal.

The amounts of salt used on the ıte's highways over the past 10 years e shown in Table 1. The figures of urse reflect year-to-year variations weather conditions as well as in-eased mileage of expressway and sier traffic. In years of particularly avy snow, more than 80 tons of salt ve been used for each mile of ex-essway traffic lane in some areas.

Increased use of salt has drastically anged the soluble salt levels in soils ›ng the highway. Table 2 gives the els found along an Interstate high-y in Cook County. The high salt levels have reduced percolation of water through the soil and have seriously damaged or destroyed the established vegetation.

Without adequate plant cover, the soil has severely eroded, increasing the rush of soil-laden runoff water into the drain sewers. The soil has clogged the sewers, and back-up water has become a problem. Loss of the turf has also greatly detracted from the appearance of the roadside.

Some areas have been concreted, asphalted, or graveled at very great cost. But besides being expensive and unattractive, these methods of handling the problem increase runoff so much that the sewer system is often inadequate. Also, since there is no soil to store the salt, the entire salt application will find its way into the runoff water to increase stream pollution.

Alternatives are considered

Several possible solutions to the problem have been considered. Urea and other nitrogen fertilizer salts could be used instead of sodium chloride for highway de-icing, but the expense is prohibitive and nitrate pollution could be serious. Installing heat cable in the highway would be very expensive, and other methods of melting snow have similar drawbacks.

Another possibility is to use salt-tolerant plants for roadside cover in areas of high salt use. Although perhaps a very short-termed solution, this alternative appears at present to be the most promising one. The Illinois Division of Highways and the College of Agriculture are conducting cooperative research to determine the feasibility of this solution.

Alkaligrass found on roadsides

So far, research efforts have been concentrated on alkaligrass (*Puccinellia* sp.). It called attention to itself in the spring of 1969, when isolated

Table 1. — Salt (Sodium Chloride) Usage on State Highways

Year (winter)	Total salt use, tons	Pct. used on Cook Co. expressways
1960-61	63,819	11.1
1961-62	141,200	11.0
1962-63	133,965	11.1
1963-64	141,000	23.1
1964-65	249,708	18.5
1965-66	125,257	21.4
1966-67	201,021	20.9
1967-68	217,483	21.2
1968-69	219,070	16.6
1969-70	309,900	16.9

Table 2. — Some Representative Soil Sodium and Soluble Salt Levels and Vegetative Cover Along Interstate Highways in Cook County

Depth of sample, in.	Sodium, ppm	Soluble salts, ppm	Vegetation
0-1½	7,280	76,800	None
0-1½	2,160	12,800	Ky. bluegrass
1-4	3,780	19,200	Alkaligrass
1-4	14,580	38,400	Alkaligrass

'D. Butler was formerly Associate Professor Turf Extension; T. D. Hughes is Assistant fessor of Turf Management; G. D. Sanks ; formerly an Assistant in Horticulture; ?. Craig is a Horticulturist, Illinois Division Highways.

bunches were found growing near the pavement and in a drainage ditch at the intersection of U.S. 45 and I-55. Most of the grass that had originally been planted in the area appeared to have been killed by salt. Plants from this site were collected for study.

One of the first problems was to determine just what kind (or kinds) of alkaligrass was becoming naturally established on the high salt areas. Grass identification is often extremely difficult, as was demonstrated during the work with this grass.

First indications were that the original clone was *P. airoides* (Nuttall alkaligrass). However, during subsequent taxonomic work, one authority suggested that the grass might be either *P. distans* or *P. airoides* × *P. distans*. It was also suggested that chromosome counts would answer the question. Accordingly, several clones of the grass were taken to Iowa State University for this purpose in the spring of 1971. Chromosomal counts on 19 different specimens proved that they were indeed *P. distans* ($n = 21$).

In the meanwhile alkaligrass was being found in numerous high-salt areas along the Interstate System in Cook County. The grass has become the major cover at the U.S. 45 and I-55 interchange and is a significant cover at many other sites (Fig. 2). It is attractive, resembling Kentucky bluegrass, and offers good erosion protection.

The wide distribution of the grass indicates that it was a contaminant in the sod or seed used for the initial turf establishment. Once the grass became established, the percentage of cover increased greatly because of prolific seed production and transport of the seed by water and mowing equipment.

Change in the roadside ecosystem, which appears to be primarily a salt effect, apparently causes a transition from Kentucky bluegrass and tall fescue to quackgrass, then to quackgrass-alkaligrass, and finally to alkaligrass with some Mexican fireweed and orach. The latter two plants are broadleaf plants that do not offer the erosion protection or aesthetic quality of the alkaligrass.

A search for a commercial source of *P. distans* and *P. airoides* has not been very successful because these grasses have not been considered economically important. In 1969, 1970, and 1971, seed was harvested along the Interstate System, and a small quantity of *P. airoides* was obtained from the USDA for research purposes.

Several research results

Greenhouse experiments have been conducted to determine how various amounts of salt in the soil affect several grasses with potential use as roadside cover. Even when soil contained 2 percent salt (by weight), alkaligrass achieved 80 percent of its normal growth, as compared with less than 60 percent for perennial ryegrass, Kentucky bluegrass, western wheatgrass, and crested wheatgrass.

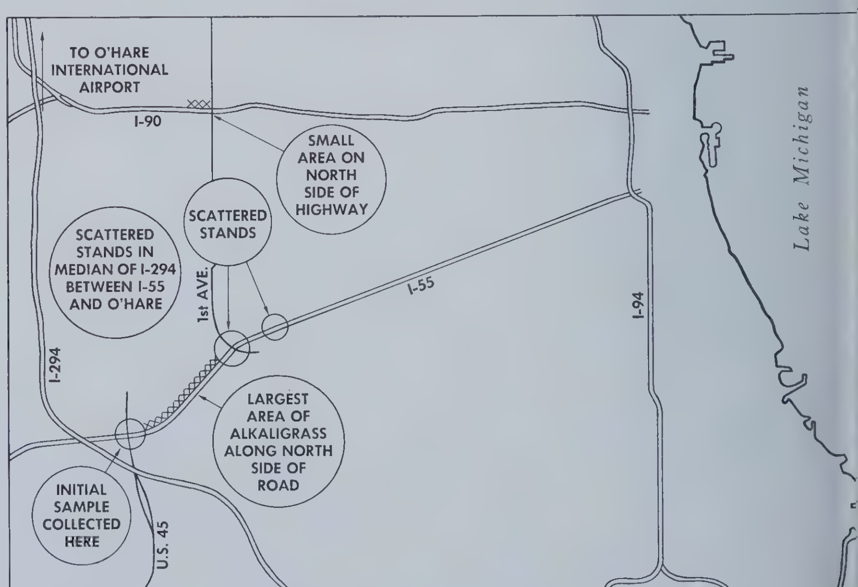
Work done thus far with the alkaligrasses has resulted in several other significant findings:

- *P. distans* collected in Cook County was slightly more salt-tolerant than *P. airoides* and *P. lemoni* from the West.
- *P. airoides* and *P. distans* were little damaged by heavy foliar applications of salt during the winter. The applications were equal to 42 tons of sodium chloride per line mile. Western and crested wheatgrass, both [illegible] which are highly tolerant to salt, we[illegible] killed or seriously injured by app[illegible]cations of this size.
- *P. distans* produces a dense attra[illegible]tive turf that compares favorably [illegible] Kentucky bluegrass.
- Although *P. distans* is a bunc[illegible]grass it can be moved as sod eith[illegible] alone or in combination with Ke[illegible]tucky bluegrass.

Problem needs continued attentic[illegible]

The appearance of alkaligrass [illegible] high-salt areas is a classic examp[illegible] of the adjustments made by pla[illegible] populations to man's continued chan[illegible]ing of the environment. Alkaligr[illegible] appears to offer at least a parti[illegible] solution to the very complex pro[illegible]lems caused by de-icing with salt[illegible] although it can at best be consider[illegible] a temporary measure. The over[illegible] situation now appears to be as go[illegible] as it was two years ago — if [illegible] better.

Continuous work with alternati[illegible] to salt, improvement of highway [illegible]sign, and research and developme[illegible] with alkaligrass and other salt-tol[illegible]ant vegetative cover is needed. T[illegible] problem is an important and serio[illegible] one that must continue to rece[illegible] attention.



Alkaligrass has been found growing spontaneously in several spots along the Inters[illegible] highways in the Chicago area. (Fig.[illegible]

Christmas Trees Are Perishable Produce

Survey of retail lots indicates that many trees lack freshness

J. J. JOKELA and T. R. YOCOM

HOW CERTAIN can you be that your next Christmas tree will be fresh nd safe?

If you cut your own tree on a tree arm, you can be sure of its safety.)isplayed away from heating ducts or adiators, with its butt immersed in vater, it will remain safe as long as hree weeks. During this time, you ould not ignite its foliage with a natch; in fact, your tree would be ess flammable than many drapery abrics and other household items.

If you buy your tree from a retail ot, it probably will not be country-esh. However, by shopping carefully nd avoiding "dry" lots, you can find tree that will freshen up when set n water and will perform almost as ell as a tree right from the farm.

etail lots surveyed

In 1967 forestry students conducted n exploratory survey to determine he freshness of Christmas trees on etail lots in Urbana-Champaign. heir results, augmented by our own bservations, convinced us that keep-ng cut trees fresh until sold is a reater problem than generally rec-gnized.

The following year we surveyed 16 etail lots located in Urbana-Cham-aign and six other communities in ntral Illinois. Since these lots, like ost others in the state, handled only mostly Scotch pine, the survey was nited to this species.

Eight trees on each lot were se-cted at random for sampling. Sam-es of one-year-old foliage were col-cted on December 2, 6, 10, 13, 17, nd 21. Two-year-old foliage was mpled on December 2, 13, and 21.

The samples were dried for 24 ours at 216° F. Moisture content was measured as the weight lost upon drying and was expressed as a percentage of oven-dry weight. Moisture content of the one-year foliage was consistently about 10 percentage points higher than that of two-year foliage from the same tree. The following discussion is confined to one-year needles.

Differences among lots

Each retailer received all or most of his trees in one shipment during the last two weeks of November. Shipments from different suppliers varied greatly in moisture content, depending on length of time since cutting and the suppliers' storage methods. Thus a retailer would tend to have either fresh trees or dry trees throughout the sampling period. This tendency is reflected in the wide range of mean seasonal moisture contents — from 67 to 121 percent — found on the different lots.

Surprisingly, Illinois-grown trees were no fresher than many of the imported trees. The three lots supplied with Illinois trees had mean moisture contents of 112, 115, and 116 percent. On six of the 13 lots selling imported trees, means ranged from 110 to 121 percent. By contrast, a mean seasonal moisture content of 135 percent was maintained on a retail lot at Sinissippi Forest in northern Illinois. This was done by replenishing the supply of fresh-cut trees almost daily.

As mentioned before, much of the variation among lots was already present on December 2. Varying conditions of storage and display — indicated by average drying rates of 0.4 to 1.8 percentage points per day during the 19-day sampling period — contributed to late-season differences among lots.

In the table below, all trees sampled are classified according to moisture content on each sampling date.

Water uptake study

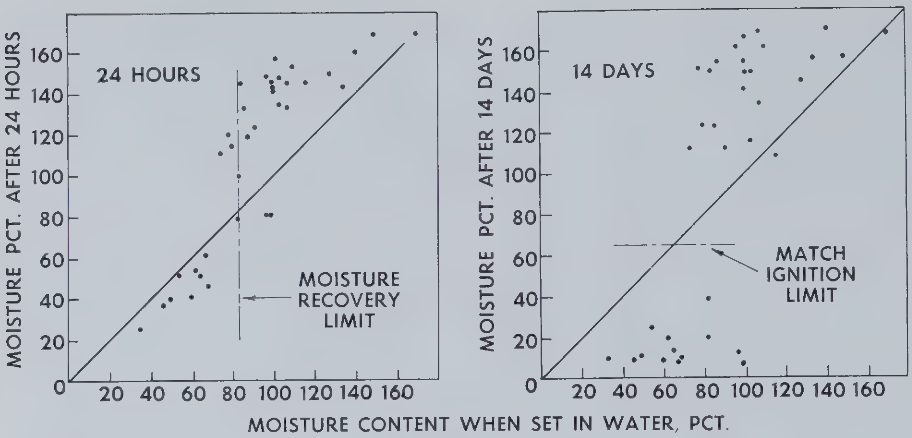
The survey results become meaningful when we consider how trees with different moisture contents vary in ability to take up water and remain fresh when displayed. In Canadian studies, freshly cut Scotch pines retained much of their original moisture content when set in water. But if a tree dried to a moisture content below 85 percent, it still continued to dry out even when standing in water. Canadian tests also showed that Scotch pine foliage becomes match-ignitible at about 65 percent moisture content, and burns violently at less than 20 percent moisture.

We repeated the Canadian tests, partly because we wanted to verify the findings. But more importantly, we wanted to use the same proce-

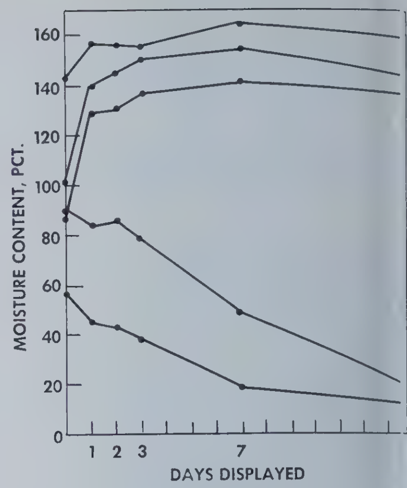
Distribution of Sample Trees on 16 Retail Lots by Moisture Content Class

Sampling date	Moisture content, pct. of oven-dried weight											Mean pct. moisture, all trees
	20-50	51-60	61-70	71-80	81-90	91-100	101-110	111-120	121 plus	**Under 90**	**Under 110**	
	Percent of trees observed											
Dec. 2.....	0	0	2	4	3	8	10	21	52	**9**	**27**	117
Dec. 6.....	0	1	1	4	5	12	22	26	29	**11**	**45**	110
Dec. 10....	1	2	7	6	10	9	35	23	7	**26**	**70**	100
Dec. 13....	3	1	2	5	15	22	22	20	10	**26**	**70**	101
Dec. 17....	3	3	5	5	13	13	27	22	9	**29**	**69**	99
Dec. 21....	2	2	5	4	13	19	27	16	12	**26**	**72**	97
Season ave.	1	2	4	4	10	14	24	21	20	**21**	**59**	104

J. Jokela and T. R. Yocom are both Asso-te Professors of Forestry.



Response of individual Scotch pine trees of varying initial foliar moisture content when set in water. Each point above the 45° or equality line represents a tree that gained moisture; each point below the line, a tree that lost moisture. (Fig. 1)



Changes in foliar moisture content wh trees with varying initial average mo ture were displayed in water. (Fig.

dures for determining moisture content that we used in the survey of the retail lots, so that test results would be applicable to the survey.

We put Scotch pine trees of varying moisture content in buckets of water, having first sawed about 1½ inches off the butts. We then displayed the trees (still in their buckets) in an air-conditioned classroom that was maintained at 72° F. and a fairly constant relative humidity of about 20 percent. Foliage samples were taken before the trees were placed in water, and 1, 2, 3, 7, and 14 days thereafter.

Our results were surprisingly similar to those obtained in Canada (Figs. 1 and 2). Of the trees with an initial moisture content of 85 percent or more, all but two gained moisture almost immediately after being immersed in water, while trees with an initial moisture content below 85 percent lost moisture.

After 14 days, the moisture contents of trees that gained moisture were still far above the match-ignition limit. Trees that lost moisture during the first 24 hours continued to dry out throughout the 14 days. Most of them dropped below 20 percent in moisture content and would have burned violently if ignited (Fig. 3).

Some trees were displayed dry under simulated home conditions. They lost 5 to 15 percentage points of moisture per day, depending upon temperature and relative humidity.

Many trees dangerously dry

On the basis of the water uptake and flammability tests, we can reach two major conclusions about the trees in the survey:

1. As shown in the table, 21 percent of the trees offered for sale over the season (more than 25 percent during the most active sales period) had foliage moisture contents below 90 percent. Most of these trees would have become highly flammable in about one week, even though displayed in water.

2. Another 38 percent (about 45 percent during the active sales period) had foliage moisture contents of 90 to 110 percent. If displayed dry, these trees would have become hazardous in about two weeks.

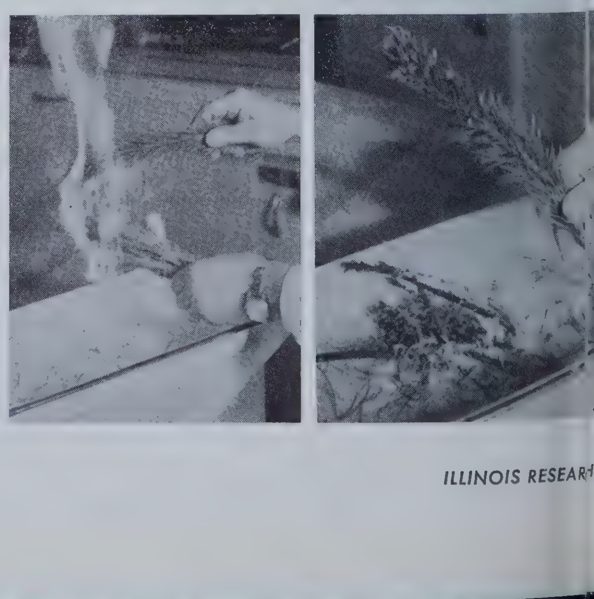
Results of the survey may not be typical of every area of the state and of every year. However, many of the trees were supplied by producers a wholesalers who operate statewi following the same general marketi practices. We believe, therefore, th our results would apply to most Il nois communities, barring unusu weather.

Finally, we wish to point out tha large proportion of the dry trees the survey came from just two lo Over 80 percent of all trees sampl on these lots had moisture conte below 90 percent.

An interesting, though disconce ing, observation is that these two l sold all their trees, indicating that t unwary consumer does not discri inate between fresh and dry tre Until the consumer does learn to d criminate, major changes are r likely to be made.

(*See page 7 for hints on selecti and displaying Christmas trees.*)

Flaming torch at bottom of near right picture came from a tree that had a moisture content of 60 percent when bought and 25 percent after a week of indoor display. The branch held above the torch did not sustain a flame. It came from a tree that still had a moisture content of 150 percent after 2 weeks of display. Its appearance after the torch was consumed by fire is shown at far right. (Fig. 3)



How to Buy, Store, and Display a Christmas Tree to Keep It Fresh

L. B. CULVER

A FRESH Christmas tree is a safe Christmas tree — at least as far ıs a fire hazard is concerned. This ıas been shown in a number of re- ;earch efforts and demonstrations (page 5). So the problem is to buy ı tree that is fresh to start with and hen to store and use it in such a way hat it will stay fresh.

Since it is the moisture in the tree hat makes it resistant to fire, we night consider that a tree's freshness s indicated both by its moisture when ›urchased and its ability to replace he moisture lost during storage and ıse. A tree with a moisture content ›f 85 to 90 percent or more can re- ›lace the water lost by evaporation rom the foliage if its freshly cut butt ; kept in fresh water (page 6). If tree has been allowed to dry below 5 percent moisture, however, it will ontinue to dry out even when it is :anding in water.

(Moisture content is usually ex- ›ressed as a percentage of oven-dry ›eight; thus a moisture content of)0 percent would indicate that the ater in the fresh sample weighed as ıuch as the oven-dried sample.)

ow can we pick a fresh tree?

Your chances of getting a fresh tree ›e best early in the season; at least, ıere has been less time for someone se to store it improperly. But even if ›u shop early, your tree may not be esh.

Unfortunately, there is no quick, sy way of accurately judging fresh- ›ss of trees on a retail lot. A bright ›lor to the foliage would normally ggest freshness, but if trees have ›en sprayed with a colorant, color ›uld be misleading. Another indica- ›n of freshness is the pliancy or ringiness of twigs and needles. ›me people claim they can feel of a tree's foliage and tell whether it is fresh. But if you are inexperienced at this sort of thing, or if your hands are chilled, or if the needles are wet with rain or sparkling with frost, you are in trouble.

Your best course is to take a cue from the adage, "The proof of the pudding is in the eating." Tell your dealer that you are going to bring the tree back if it does not pass the 12-hour water consumption test. If he will not agree to such an arrangement, you can look elsewhere for your tree or, at the very least, not go back next year.

Incidentally, the dealer can assure himself of a supply of fresh trees by using the test himself and by requiring the supplier to send him trees fresh enough to pass the test. Of course, it is up to him to keep his trees fresh after he gets them.

The 12-hour test

The test is simple. As soon as you bring the tree home, cut off 1 or 1½ inches from the butt and promptly stand the tree in a pail of fresh water. Put the tree and bucket in a room with temperature and humidity similar to those of the room where the tree will be displayed. After 12 hours, measure the amount of water that the tree has consumed. You can do this by comparing water volumes at the beginning and the end of the 12-hour period. Or you can mark the water level at the beginning of the period and then, after 12 hours, measure the amount of water needed to bring the water back up to the original level.

The amount of water consumed in the test can vary considerably, depending on species and size of tree and on temperature and relative humidity of the room. If the tree is 6 or 7 feet high and if room temperature and humidity are average for early December, you might reasonably expect an acceptably fresh tree to take up a pint or more of water during the 12 hours.

Storage and display

If your tree has taken up a significant amount of water, showing it is fresh, your job now is to keep it fresh by proper storage and display. The best storage place is a cool room or garage, where the tree is out of the wind and sun. The butt should be kept in fresh water during storage.

If you store the tree for a week or more, saw 1 or 1½ inches off the butt before you display it. This will remove any fouling of the surface that may have developed after you made the first cut for the 12-hour test.

For safe, trouble-free display of the tree, a good stand or holder is essential. It must keep the tree erect without tipping and it should have an adequate reservoir for water to keep the tree fresh.

The containers of manufactured stands vary in gross capacity from a token few ounces to 4 or 5 pints. Since you have to keep the water level above the cut surface of the butt to retain freshness, the working volume of a 4- or 5-pint container would be about a quart. This means that water needs to be added every 12 to 24 hours.

If you get yourself a 5-gallon paint pail, a few stones, and some sand, you can make a safe container with a good water-holding capacity. Add 4 to 6 inches of water to the pail, immerse the butt of the tree, and wedge it to the center of the pail with stones. Add enough sand to keep the tree erect, and flood the sand with water. By keeping the sand flooded, you will have enough water to last several days if you wish to go away.

Decorate the pail according to your taste, and you will have a stand that is attractive as well as safe.

B. Culver is Associate Professor of Forestry d Extension Forester.

Storage of High-Moisture Field Corn

M. T. DANZIGER, M. P. STEINBERG, and A. I. NELSON

THE PICKER-SHELLER requires a corn moisture content of about 23 percent for most efficient operation. Yet corn at this moisture is likely to spoil. Most commonly, spoilage is due to molds, the spores of which are already present on the harvested corn. An estimated 250 million bushels of corn or more is thus lost in the United States every year.

One way to prevent mold growth is to dry grain to about 15 percent moisture. A second technique that has been investigated is to reduce the oxygen content of the storage atmosphere. Addition of chemicals may be another approach, as shown by Olver, Shove, and Massie (ILLINOIS RESEARCH, 5:3).

A recent study in the Department of Food Science was conducted to determine how continuous flushing with carbon dioxide-air atmospheres, alone or in combination with partial drying or a preservative, affects the length of storage time before corn spoils. The preservatives tried were sorbic acid and K sorbate, which are used to preserve high-moisture foods like cheese.

Yellow dent field corn of the XL66 hybrid was used in the experiments. The corn was stored in ½-gallon Mason jars holding 2 pounds of corn, except in the last experiment, when 2.5-cubic foot bins holding 25 pounds were used. The various atmospheres were obtained by mixing pure carbon dioxide with air. Flushing rates were 1/6 cubic foot per hour in jars and 2 cubic feet per hour in bins. All experiments were at 70 ± 3° F.

Typical growth pattern

On untreated corn in an atmosphere of 90 percent carbon dioxide and 100 percent relative humidity, yeast plus mold counts increased about tenfold for each 3 days of storage, going from 2,000 to 2,200,000 in 9 days (Table 1). Similar increases were found in untreated corn at 100 percent relative humidity in all atmospheres studied.

A much different growth pattern was observed in wet corn that had been treated with 0.1 percent K sorbate (Table 1). The yeast plus mold counts per gram of dry weight decreased from 2,700 to less than 100 within 9 days and stayed under 100 for another 6 days. After that, however, the counts began to increase at about the same rate as on untreated corn. The separate mold and yeast counts remained parallel to the yeast plus mold counts.

A similar inhibition followed by a normal growth rate was observed in all corn treated with 0.1 percent or 0.05 percent K sorbate if stored at carbon dioxide levels of 40 percent or more, but not if stored in air. It was concluded that the K sorbate did not act as a true preservative in this case, but that, in conjunction with high carbon dioxide, it caused the mold to go through a dormant period.

Safe storage time defined

To relate the counts from each experiment to the "storability" of wet corn, a criterion labeled safe storage time (S.S.T.) was developed. S.S.T. was arbitrarily defined as the time required to reach a yeast plus mold count of 130,000 per gram of dry weight.

By this criterion, when untreated corn was stored in air at an equilibrium relative humidity of 100 percent, the safe storage time was only 5 days (Table 2). Increasing the carbon dioxide in the atmosphere from 0 to 90 percent added only about a day to the safe storage time.

Corn moisture and S.S.T.

To investigate the effects of corn moisture on S.S.T., high-moisture corn was air-dried to equilibrium moisture contents of 19.5 to 23.9 pe[r]cent, roughly corresponding to equ[i]librium relative humidities of 91 t[o] 100 percent.

Decreasing moisture content fro[m] 23.9 to 19.5 percent increased th[e] S.S.T. of untreated corn stored in a[ir] from 5 days to 10 days (Table 2). Storage in an atmosphere containin[g] 80 percent carbon dioxide pushed th[e] S.S.T. of 19.5-percent corn to 34 day[s]. It is interesting to note that the sam[e] S.S.T. — 18 days — was observe[d] both for 20.5-percent moisture cor[n] stored in 20 percent carbon dioxid[e] and for 21.5-percent corn in 80 pe[r]cent carbon dioxide.

As expected, the S.S.T. was ex[-]tended in all atmospheres as moistur[e] content was reduced. Operating to[-]gether, decreases in moisture and in[-]creases in carbon dioxide had a syne[r]gistic effect on S.S.T.

K sorbate vs. sorbic acid

In one series of tests, high-moistu[re] corn samples were treated with 0.[1] percent K sorbate and with 0.1-pe[r]cent sorbic acid to compare the ef[-]fectiveness of these chemicals.

Treatment with K sorbate pro[-]longed storage life by less than 2 da[ys] when corn was stored in air. In a[n] atmosphere containing 90 percen[t] carbon dioxide, however, S.S.T. wa[s] 26 days. This was four times longe[r] than the S.S.T. of either control (un[-]treated corn in 90 percent carbon di[-]oxide, or sorbate-treated corn store[d] in air).

In air storage, the sorbic aci[d] treatment prolonged the S.S.T. o[f] corn only 1 day longer than did th[e] sorbate treatment. This differenc[e] was extended to more than 4 days i[n] an atmosphere containing 60 percen[t] carbon dioxide.

Since the acid gave only slightl[y] better results than the sorbate an[d] also imparted an odor to the cor[n] while the salt did not, all furthe[r] work was restricted to K sorbate.

M. T. Danziger was formerly Research Assistant in Food Science; M. P. Steinberg is Professor of Food Engineering; and A. I. Nelson, Professor of Food Processing.

Table 1. — Typical Mold, Yeast, and Total Microorganism Counts on Corn During Storage at 70° F. and 100 Percent Relative Humidity in an Atmosphere of 90 Percent Carbon Dioxide and 10 Percent Air

'reatment	Storage time, days	Count per gram dry weight			
		Yeast plus mold	Mold	Yeast	Total
ıtreated	0	2,000	1,300	700	40,000
	3	37,000	5,000	32,000	...
	6	110,000	30,000	80,000	...
	9	2,200,000	400,000	1,800,000	20,000,000
1% K sorbate) cc of solution per ɔounds of corn)	0	2,700	1,800	900	40,000
	3	900	800	<100	...
	6	700	600	<100	...
	9	<100	<100	<100	...
	12	<100	<100	<100	...
	15	<100	<100	<100	...
	18	800	700	<100	
	21	3,600	2,800	800	
	24	10,000	8,000	2,000	...
	27	360,000	130,000	230,000	...
	30	1,200,000	900,000	300,000	30,000,000

Table 2. — Average Safe Storage Time of High-Moisture Corn With and Without Chemical Preservatives, Stored at 70° F. at Various Relative Humidities and in Various Atmospheres

'reatment	Equilibrium relative humidity, pct.	Storage atmosphere, pct. carbon dioxide					
		0[a]	20	40	60	80	90
		Safe storage time, days					
ıe	100	5.0	5.0	5.0	5.9	...	6.4
ıe	95	6.9	...	...	...	18.0	...
ıe	93	...	18.0	...	...	...	...
ıe	91	10.4	...	...	...	34.5	...
% sorbic acid[b]	100	7.9	..	...	27.5	...	...
% K sorbate[b]	100	6.9	...	17.12	23.3	...	26.3
5% K sorbate[b]	100	5.5	..	...	...	...	10.6
% K sorbate[b]	100	8.1	...	...	...	...	...

[a] 100 percent air. [b] 20cc of solution per 2 pounds of corn.

ume and wetting agent

'urther experiments were done to ermine whether S.S.T. was af- :ed by the volume of K sorbate ıtion applied to the corn or by the lition of a wetting agent to the so- on. The final K sorbate concentra- ı in these experiments was 0.1 per- t on a wet corn basis.

.S.T. in air and 100 percent rela- humidity increased from 6.9 days 8.3 days when volume was in- ısed from 20 to 30 cc. Thus, better ribution of the preservative did ı somewhat.

amples treated with 20 cc sorbate tion had practically the same T. with and without a wetting ıt (0.01 percent of Triton X-100). This indicates that wetting the corn was not a problem.

Sorbate concentration

When applied together, the K sorbate (0.1 percent concentration) and high carbon dioxide treatments were synergistic in inhibiting mold growth (lines 1 and 6, Table 2). But would this synergistic relationship hold true with different concentrations of K sorbate? To answer this question, samples treated with 0, 0.05, 0.1, and 0.2 percent K sorbate were stored in atmospheres of 0 to 90 percent carbon dioxide.

In air, S.S.T. was lengthened only slightly by increasing K sorbate concentrations from 0.05 percent to 0.1 percent and from 0.1 percent to 0.2 percent (Table 2). At 90 percent carbon dioxide, however, S.S.T. was 6 days for untreated corn; 10 days for corn treated with 0.05 percent K sorbate; and 26 days for corn treated with a 0.1-percent concentration. At the intermediate levels of carbon dioxide, S.S.T. of corn treated with 0.1 percent K sorbate was also greatly lengthened. It was 17 days at 40 percent carbon dioxide and 23 days at 60 percent carbon dioxide, as compared to 5 and 6 days for the untreated controls.

It was concluded that increasing K sorbate concentration had a more pronounced effect as the carbon dioxide in the atmosphere was increased. However, increasing carbon dioxide from 60 to 90 percent lengthened S.S.T. by only 3 days. Thus, the 90-percent concentration of carbon dioxide probably would not be warranted from an economic standpoint.

Effects of sample size

It was important to know whether scale-up of sample size would affect the results described above. Untreated corn and corn treated with 0.1-percent K sorbate were stored in 2.5-cubic foot bins at 100 percent relative humidity and were flushed with 90 percent carbon dioxide.

After 30 days' storage, the sorbate-treated sample contained a yeast plus mold count of 950,000, as compared to the 1,200,000 count found on the smaller sample that had been stored in a jar. The growth rate was much higher on untreated corn, with relatively high populations being reached after only 6 days' storage. Since the counts were not appreciably affected by amount of corn, results of this study are indicative of results with large masses of corn under similar storage conditions.

On the basis of this study, we can say that a high carbon dioxide atmosphere, in conjunction with either partial drying or treatment with K sorbate, allowed the experimenters to store wet corn for one month. However, much work, including economic studies, must be done before these procedures can be recommended to farmers.

"Clodhopper" Helps With Soil Studies

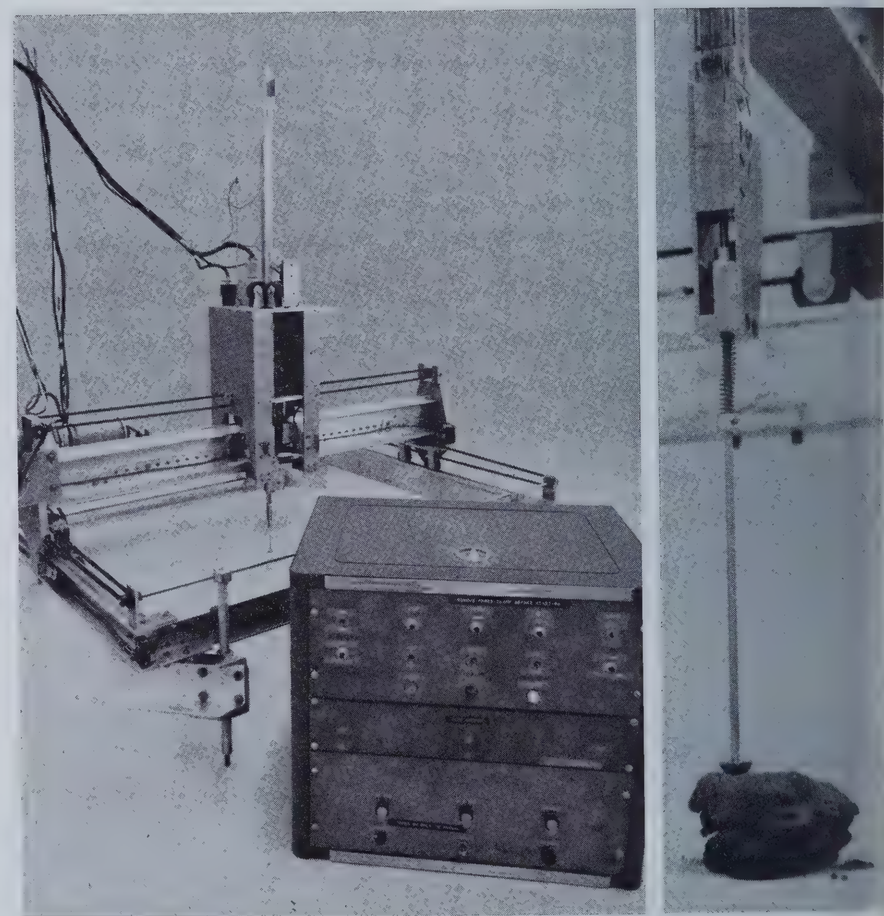
New device automatically measures and records changes that rainfall or tillage operations cause in the soil surface

J. KENT MITCHELL and BENJAMIN A. JONES, JR.

AN UP-TO-DATE "clodhopper" is helping to measure the changes that rainfall or various tillage methods may cause in the contour of the soil surface.

To determine variations in the soil surface accurately, measurements of a sample plot have to be made an inch apart in both directions. For example, a 36-inch square plot would require 1,296 separate measurements. In the past, these measurements had to be made manually, obviously requiring a great deal of time as well as permitting the opportunity for human error.

All this has been changed by a new profile measuring device (PMD), nicknamed the "clodhopper" because of its ability to move over the soil. As it moves, it automatically measures and records variations in the elevation of the soil surface. It was developed by the Department of Agricultural Engineering with the aid of investigators at Iowa State University who had made a similar device.



Profile measuring device with control cabinet is shown at left; probe touching the s surface, at right. (Fig.

How PMD works

The PMD shown in Figure 1 is constructed mostly of aluminum so it can be moved and positioned by two men. Also the control and recording systems are designed to be transported without disassembly. The entire system operates automatically after it is assembled and positioned over a plot that is to be measured.

At each measurement point (that is, a 1-inch grid location) a probe is driven downward until it touches the soil surface (Fig. 1). When the probe touches the surface a miniature snap-action switch is activated and the probe is retracted. The probe carriage then moves 1 inch along the center rail to the next grid point and the probe sequence is repeated. When the probe gets to the end of the center rail, the probe carriage returns to i first position on the rail, and the ra moves along the main frame a di- tance of 1 inch. Then the probe sta its sequence again and this procedu is repeated until the entire surface measured.

The movements and sequences f the PMD are controlled by the el-

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nic components in the control cab- t shown in Figure 1. This cabinet ntains power supplies, switching uipment, and the logic or sequenc- ; controls. It is connected to the ID by signal and power cables.

In addition to the mechanical and ntrol systems, the PMD also has a a recording system that converts vertical probe travel distance to a tage signal. The voltage when the obe touches the soil is a measure of distance between that point on soil surface and the PMD refer- e elevation. This voltage is re- rded electronically and processed er with a digital computer.

ta have many uses

The data from this type of instru- nt may be used in many ways. For tance, if the effects of tillage on soil surface are being studied, n a line of points can be plotted as wn in Figure 2. Such a plot be- e and after tillage operations pro- es a visual picture of the changes. e data points may also be used to vide a statistical description of the ghness of the soil surface.

The PMD was developed specifi- ly so that the volume of water red on the soil surface could be culated from surface elevation nts. For such a calculation, a con- r map of the soil surface can be wn (Fig. 3). The volume from lowest to the highest contour can n be computed by measuring the as at each contour interval and ltiplying by the interval between contours. Another way to calcu- the volume is to process the soil ace data on a digital computer. s eliminates the need for drawing ontour map.

nfall-runoff studies

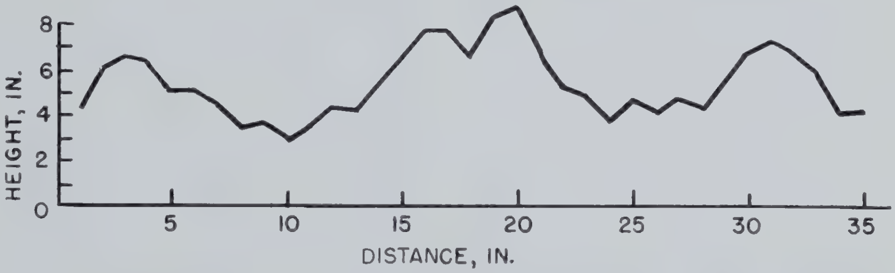
The PMD has been used to study effect of surface depression stor- on runoff and the changes in sur- depression storage during rain- It is important to quantify ace depression storage because it reases surface runoff by retaining e of the rainfall on the soil sur- . The water trapped in surface ressions is added to subsurface water through infiltration during and after the rainfall.

Initial tests were on a Flanagan silt loam soil that had been tilled by hand to a very rough condition. Differences between the highest peaks and lowest valleys ranged from 5.6 to 10.5 inches on the different plots. Surface storage varied from 2.6 to 5.3 inches. The figures for surface storage represent the average depth of storage over the entire surface of the plot, even though storage is primarily in pockets or valleys. They are thus a measure of total storage from the lowest to the highest point of the soil surface. More than half of the volume would be above a depth which would contribute to runoff.

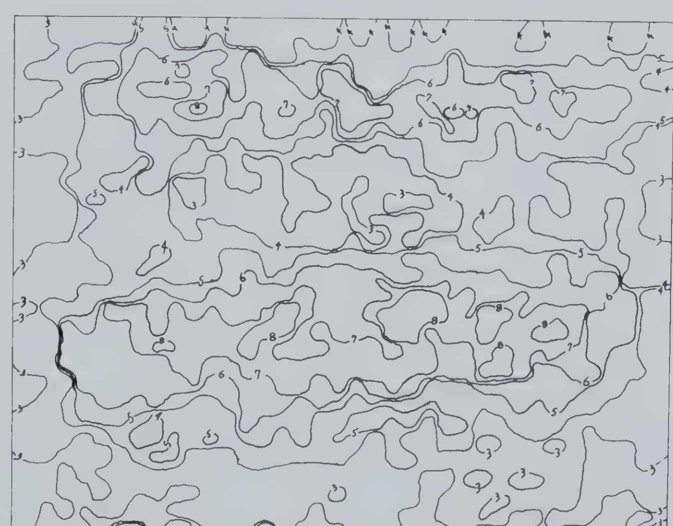
Rainfall intensities of 3 to 12 inches per hour were applied to the plots for periods of 10 to 50 minutes. The rainfall reduced surface depression storage by as much as 1.2 inches or 27 percent.

In later tests on a Sparta loamy sand soil, valleys were found to range from 4.4 to 7.5 inches deep, and surface storage varied from 2.1 to 4.4 inches. Application of rainfall reduced storage by as much as 1.8 inches or 50 percent. In general, rainfall applications caused a greater and more rapid decrease in maximum depths and in surface depression storage on this loamy sand soil than on the Flanagan soil.

The PMD developed for this study has provided a fast and accurate method of collecting the data needed to describe the soil surface. The entire data-collection and analysis process permits the surface depression information to be computed with a digital computer, thereby reducing the possibility of computational errors.



Profile measuring device data can be used to plot a profile of soil surface. (Fig. 2)



A contour map, drawn from PMD measurements, permits calculation of the volume of water stored on the soil surface. (Fig. 3)

The Family's Life Style and the Near Environment

How do people perceive their community, their neighborhood, their house? What are their expectations for their future environment? What are their wants?

MARILYN M. DUNSING and JEANNE L. HAFSTROM

MAJOR CRITERIA for determining a family's life style may be the environment in which it lives and the family's perception of that environment.

"Do you expect to be living in this community . . . in this neighborhood . . . in this house one year from now?" "Five years from now?"

"Do you want to be living in this community or in one like it . . . in this neighborhood or in one like it . . . in this house or in one like it one year from now?" "Five years from now?" If so, "Why?" If not, "Why not?"

These and similar questions were recently asked of 564 homemakers to find out how they felt about their physical environment.

Households selected for the study were limited to those that included at least one mother or mother-substitute under 65 years of age and at least one child under 18 years of age. Student families were not included. Households were stratified on the basis of occupation, and were selected from the Champaign-Urbana City Directory by use of a random sampling technique. The interview-questionnaire method was used to collect information from the homemakers during the last half of 1970 and early 1971.

Sample characteristics

The 564 homemakers averaged 37 years of age and had been married an average of 15.7 years. Family size averaged 4.6 persons. The women had an average of 12.9 years of schooling, with 45 percent having had four years of high school; 17 percent, fewer years of schooling; and 38 percent, schooling beyond high school.

Twenty-two percent of the homemakers were born in Champaign County; 34 percent were born elsewhere in Illinois; 16 percent were born in the North-Central Region but outside of Illinois; and 28 percent were born in other states or in foreign countries.

Of the husbands, 56 percent were in white collar occupations and 44 percent in blue collar occupations. Median income of the families was $12,146 before taxes.

The community

Each homemaker was asked if she expected to be living in Champaign or Urbana in one year and in five years. She was also asked if she wanted to be living in the same city or in one like it in one year and in five years.

Most of the women (91 percent) expected to be living in the community in one year, and 82 percent said they wanted to be living there. Fewer of the women (65 percent) expected to be living in the community in five years, while 67 percent wanted to be living in the community or one like it at that time.

The women were then asked to give their reasons for wanting or not wanting to be living in the community for the two time periods. The reasons that the women gave for their choices were about the same in relative importance whether the shorter or th longer time was being considered.

"It's home," said about one-thi of both those who wanted to be livi in the community in one year a those who wanted to be living the in five years. About the same pe centage indicated that their hu bands' work was there.

Over one-fourth said they liked t size of the town or they wanted stay settled there. About one-fifth a swered that they were born or rais there, their roots were there, or th friends and relatives lived the About the same percentage said th liked a university town with its cu tural, intellectual, or economic a vantages. In addition, 16 perce said the schools were good or t community was a good place to ra children.

Size of community was the ch thing mentioned by the women w did not want to be living there in o year or in five years. About two-fif of these women said they preferre different-sized community — usua a smaller one. A desire to live another state, region, or clim was mentioned by 28 percent of t women.

The neighborhood

When asked whether they expect to be living in the neighborhood one year, 82 percent of the respo dents said yes, and 78 percent sa they wanted to be living in the neig borhood or one like it then. R sponses were quite different, howev when the women were asked to lo ahead five years. Somewhat less th half (48 percent) indicated that th

Marilyn M. Dunsing is Professor of Family Economics; Jeanne L. Hafstrom is Assistant Professor of Family Economics, Department of Home Economics. Data in this article were collected as part of the Illinois Contributing Project to the NC-90 Regional Project on Factors Determining the Life Styles of Disadvantaged Families.

ected to be living in the neighborod after that length of time, but percent said they wanted to be ng in the same neighborhood or milar one.

Of both those who wanted to live re in one year and those who nted to live there in five years, out 60 percent said that the neighhood was good, kept up, quiet, or oyable. Location convenient to rk, stores, churches, and schools s given as a reason by 37 percent of se who wanted to be in the neighhood in one year, but only 33 pert of those who wanted to be living re in five years. By comparison, the son that they knew and liked the ghbors or that their friends lived the neighborhood was given by a ger percentage of the homemakers o wanted to be living there in five rs (34 percent) than of those who nted to be living there in one year percent).

or both time periods, one-eighth the women said they liked the ghborhood because people were ilar to them in values or in race. o, for both time periods, about -eighth gave as their reason that y owned their house, they didn't to move, or they planned to re- there.

Vhen women who didn't want to in the neighborhood were asked y not, inconvenience of location or of community was mentioned by percent of the women who did not nt to be there in a year and 55 perof those who didn't want to be e in five years. They felt the ghborhood wasn't convenient to k, stores, and schools, or they preed country or small town living. both time periods, 43 percent of women said they wanted a better hborhood for the children or they ted to be with people who were e like they were.

large number of the women said wanted more desirable surround-. This reason was mentioned by percent of the women who did want to be living in the neighood in one year and by 32 per- of those not wanting to live there ve years. Either they felt that the presence of stores, apartments, or duplexes made the neighborhood undesirable, or they felt that the neighborhood was run-down or unsafe.

The house

Although 80 percent of the respondents expected to be living in their present house in one year, only 70 percent wanted to be living in it or one like it then. On the other hand, when looking ahead five years, 46 percent of the homemakers expected to be living in their present house, but 50 percent wanted to be living there or in a similar house.

For many of the women, their house was "home," they were happy with it and liked it, or it was comfortable. Such reasons were given by 40 percent of those who wanted to live in their present house or one like it in one year or in five years.

External factors, such as location, neighborhood, or good neighbors were next in importance for the women who wanted to be living in their house in one year. Such factors were mentioned by 35 percent of these women. However, external factors were mentioned by a smaller percentage (29 percent) of the homemakers who wanted to be living in their present house in five years.

By comparison, the reason that the house meets family needs was given by a larger percentage of the homemakers wanting to be living in their present house in five years (39 percent) than of those who wanted to live there in one year (32 percent).

About one-fifth of the women wanting to be in their present house for both time periods gave money-related reasons. They considered that the rent or mortgage payments were reasonable or all they could afford.

Size was the main reason given by the women who did not want to be living in their present house for either time period. It was mentioned by 43 percent of those who did not want to be there in one year and 48 percent of those who did not want to be there in five years. Most of these homemakers felt that they needed a larger house.

External factors such as bad location or changing neighborhood were mentioned by about two-fifths of those who didn't want to be in their present house in either one year or five years. Over 30 percent of all those who didn't want to be in the same or a similar house, whether in one year or in five years, gave one or more of the following reasons: a desire to own their own house, a desire to change the type of housing unit, or the high cost of rent or upkeep.

Expectations and Wants of 564 Homemakers Concerning Their Physical Environment for Two Time Periods

	1 yr. from now	2 yr. from now
	Pct. of women	
Community		
Expect to live there	91	65
Want to live there	82	67
Neighborhood		
Expect to live there	82	48
Want to live there	78	62
House		
Expect to live there	80	46
Want to live there	70	50

Summary

As might be expected, somewhat more of the women were satisfied with the community as a whole than with their neighborhood, and more were satisfied with their neighborhood than with their particular house. Yet 70 percent of the women wanted to be living in their present house (or one like it) in one year and 50 percent wanted to be living there in five years.

More of the women expected to be living in the same community, neighborhood, or house in one year than wanted to be living there. But when the women were asked to look ahead for five years, the opposite was true. More of them wanted to be living in the same environment, or one like it, than expected to be living in the same community, neighborhood, or house. Thus the homemakers' perceptions of their environment relative to their expectations were more favorable for the longer than for the shorter period.

Activity of Proteolytic Enzymes in Spermatozoa

Results of current studies may lengthen the storage time of semen and increase the fertility of livestock

D. L. GARNER and C. N. GRAVES

BASIC STUDIES on enzyme systems of mammalian spermatozoa are providing new insights into the problem of maintaining the fertility of semen during extended storage.

The studies have been principally concerned with proteolytic enzymes. These enzymes can break down protein molecules by cleaving the chemical bonds between the amino acid subunits that are sometimes called the building blocks of proteins.

Proteolytic enzymes were detected in spermatozoa as early as 1930. Only recently, however, has evidence been found that these enzymes may be the means by which spermatozoa penetrate the outer layers of ova during fertilization. The principal layer surrounding the egg and hindering sperm penetration is the zona pellucida, which consists of a thick, transparent mucoprotein. Since proteolytic enzymes are capable of dissolving the zona pellucida, it is thought that they facilitate the sperm's penetration of this layer by digesting a passage through it.

Acrosin studied

Spermatozoa ultimately lose their fertilizing capacity during storage. Is this loss due to a degeneration of the enzyme systems necessary for fertilization? An answer to this question was sought in recent experiments in the Department of Dairy Science.

D. L. Garner is Research Associate and C. N. Graves, Associate Professor of Physiology, Department of Dairy Science. The work reported here was supported in part by a postdoctoral fellowship from the National Institutes of Health (1 FO2 HD-44, 623-01).

The experiments involved the proteolytic enzyme "acrosin," which had previously been implicated in the fertilization process. This enzyme is localized in the acrosome, a cap-like structure that covers the front half of the spermatozoan head.

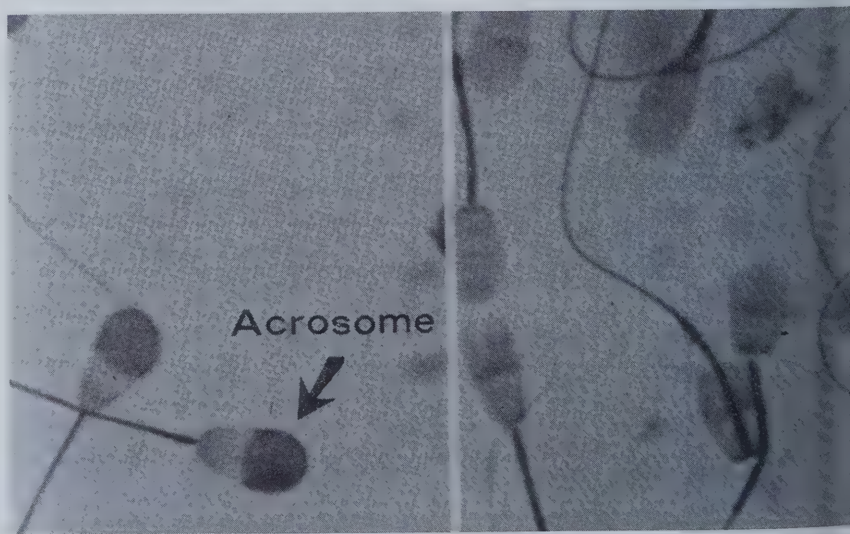
Researchers in England had shown that acrosomes could be dislodged from sperm cells by detergent treatment. The acrosomes could then be separated from the remaining portion of the cells by differential centrifugation. Spermatozoa before and after detergent treatment to remove the acrosomes are shown in Figure 1.

Acrosomal materials that have been isolated by detergent treatment exhibit relatively little acrosin activity. This is because they contain a natural enzyme inhibitor (a molecule that suppresses activity). The inhibi[tor] must therefore be removed from [the] enzyme before acrosin activity can [be] demonstrated. Since the inhibitor [is] a smaller protein than the enzy[me,] the two can be separated by elect[ro]phoresis. Through this process, p[ro]tein molecules are separated on [the] basis of size and ionic charge by si[ev]ing in a gel.

Three acrosin fractions

Once the inhibitor is separa[ted] from the enzyme, the gel is stai[ned] so that the sites of enzyme acti[vity] show up as bright red bands. T[he] term "zymographic" is used to [de]scribe the patterns of enzyme acti[vity] that are obtained in this way.

Staining of duplicate gel samp[les] by two different methods showed t[...]



Stained bovine spermatozoa before (*left*) and after (*right*) detergent treatment to [re]move the acrosomes (magnified about 2400 times). (Fig[...]

ine acrosomal materials contained least 12 protein fractions. Three hese fractions possessed acrosin acty. A comparison of the acrosomal tein and acrosin fractions obtained n the spermatozoa of four dairy ls is shown in Figure 2.

'inding three acrosin fractions in osomal materials was unexpected. aised a question as to whether the matozoa of other species also pos- multiple acrosin fractions. To wer this question, rabbit and ram matozoa were studied. Three acrofractions were found in the acroal materials from each species.

'he next question was: Why do matozoa possess three similar ene fractions? Studies were conted with rabbit spermatozoa in an mpt to find the answer.

esults of these studies suggested the multiple acrosin forms reed from interaction between pro- molecules. When material coning large amounts of acrosin bitor were added to acrosomal act, one acrosin fraction was comely eliminated and another was comitantly increased. It is thus onable to conclude that one frac- is a free acrosin molecule; an-r arises from the interaction ding) between an acrosin mole and an inhibitor molecule; and third fraction is a larger molecule h may be an aggregation of two sin molecules.

nges during storage

fter the three fractions were iden-l, experiments were conducted letermine whether changes oced during storage. Acrosomes removed from bull spermatozoa analyzed for acrosin activity after , 48, 72, and 96 hours of storage C.

e three acrosin fractions were cted after all storage intervals ed, and little change in relation orage time was noted. The apnt stability of bovine acrosin frac- may be related to the high de- of success in maintaining the ity of bull semen during storage.

a similar storage experiment with ram spermatozoa, changes occurred in the relative amounts of the three acrosin fractions. In addition, a fourth acrosin fraction became evident after storage. These changes in ram acrosin fractions may at least partly explain the rapid loss in fertilizing capacity that occurs during storage of semen from this species.

Intrauterine changes

Successful maintenance of fertilizing ability during storage requires that spermatozoa still be capable of traversing the female tract and fertilizing ova. Therefore, one must examine changes that occur during the interval between insemination and fertilization as well as the changes during storage.

The spermatozoa of most mammalian species must reside in the female reproductive tract for a period of time before they are capable of penetrating the ova. The ability to fertilize the ova is the result of a physiological change termed "capacitation," which occurs while the spermatozoa are in the female reproductive tract.

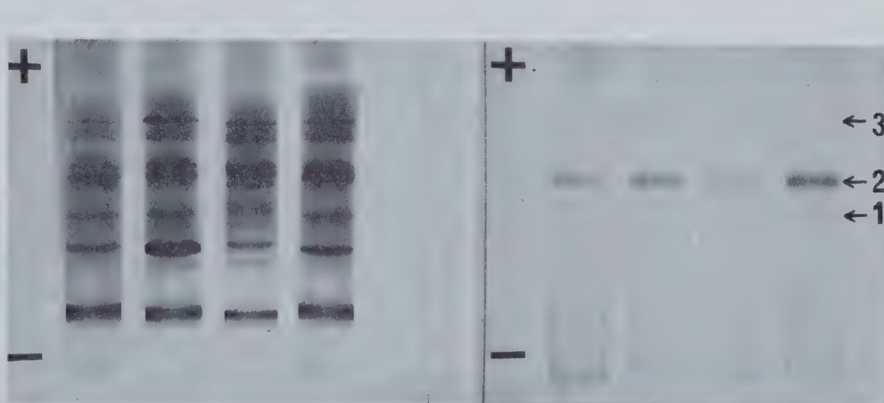
Results of previous studies in Georgia had suggested that at least part of the capacitation process involved removal of acrosin inhibitor from the spermatozoa. An experiment was therefore designed to determine whether intrauterine incubation of spermatozoa caused changes in the acrosin fractions. Rabbit spermatozoa were surgically deposited in the uteri of several female rabbits and were recovered after different periods of uterine incubation. The acrosomes were removed from these spermatozoa and were zymographically analyzed for acrosin activity.

It was found not only that uterine incubation did change the acrosin fractions, but also that a predictable shift in the fractions occurred with increased incubation time. The acrosin fraction with bound inhibitor progressively decreased, while the fraction without bound inhibitor increased. Additional acrosin fractions, different from the three found in the acrosome before uterine incubation, were also detected.

Significance of results

The evidence obtained thus far confirms the value of basic biochemical studies of spermatozoan enzymes and has opened several new avenues by which we may be able to increase the fertility of domestic livestock. For example, experiments are now in progress to test the feasibility of including reversible inhibitors of proteolytic enzymes in diluents used for semen storage. The studies on intrauterine incubation may ultimately allow us to determine more precisely what biochemical events occur during capacitation.

Finally, a basic understanding of the enzyme systems involved in fertilization could not only increase livestock production but also help to develop new and presumably safer methods for human contraception.



Gel electrophoretic patterns of acrosomal materials obtained from the spermatozoa of four bulls. The gels were stained for protein (*left*) and acrosin activity (*right*) after electrophoresis was completed. Three acrosin fractions, indicated by the numbers, were found. (Fig. 2)

Economics of the Agricultural Act of 1970

R. G. F. SPITZE

When the President signed the Agricultural Act of 1970 on November 30 of last year, the curtain was lowered on one of the most protracted policy-making dramas of recent years.

The round of policy-making that led to the Act had begun in 1968. Going was slow, however, because of divergent views among several centers of power: (a) Secretary of Agriculture Hardin; (b) the "Farm Coalition," a new coordinated effort of farm organizations, including the National Grange, the National Farmers Union, and the National Farmers Organization; (c) the American Farm Bureau Federation; and (d) the Congressional agricultural committees.

During the closing negotiations, plane loads of farmers and leaders went to Washington to press their views, and the House and Senate almost came to an impasse over the final conference report.

When the Act was finally hammered out and signed, the pattern of public price and income policy for feed grains, wheat, cotton, wool, and dairy products was set through 1973. The Act also extended the Food for Peace Program (P.L. 480), under which some $20 billion worth of farm products have been distributed abroad since 1954. Policies as to conservation, credit, education, and research were not affected.

Background setting

Beginning with the Federal Farm Board of 1929, public policy has been in effect to enhance farmers' prices and incomes by means of price supports, production controls, income payments, and surplus disposal. At the outset of the 1960's, policy was redirected in several ways. Most compulsory crop production control was replaced by voluntary acreage withdrawal, which usually has involved half of the feed grain producers. Also, high price supports were lowered, and direct government payments to farmers were begun. This policy was a "partnership" between farmers and the government to help maintain a balance between growth in supply and in demand of farm products and to supplement farmers' incomes. Livestock production was affected indirectly through feed grain prices.

When the new Agricultural Act was being debated, few spokesmen were completely satisfied with existing policy; yet the prevailing opinion was that governmental support of farmers' prices and income should continue. With the usual compromise of public policy-making, the new Act neither strengthens the public's support of farmers as desired by some, nor dismantles it as urged by others. Essentially, it continues the thrust of policies during the past decade.

Amazingly, the basic economic conditions of agriculture that precipitated the first price-income policy still persist:

1. **New technology continues to be adopted rapidly,** resulting in high labor productivity. Since 1950, output per man hour has increased 5.5 percent a year on farms as compared with 2.5 percent for nonfarm labor.

2. **Farm people are still migrating to the city,** with farm population dropping from 8.7 percent of the total population to 4.7 percent during the past decade.

3. **Demand for farm products is highly inelastic,** with coefficients of + .15 against income and − .3 against price. (The last figure means that price varies greatly with slight changes in quantity marketed.)

4. **Farmers buy and sell on a relatively competitive market.** They have little power to "balance" their production or regulate their prices.

Results of these four conditions a
quite predictable: continued dow
ward pressure on product prices a
a lag in relative income returns
production factors, unless counter
by other forces.

The chart and table on page
show some of the specific econon
trends of the past decade. Th
trends, which were partially due
governmental policies, provided t
setting for the discussions leading
the new Agricultural Act.

As indicated in columns 2 and
of the table, farm output has slow
to nearly pace population grow
Although prices received by farm
strengthened slightly, the prices p
by farmers and retail food prices b
went up much more (columns 4,
6). Per capita income of the fa
population was still less than ot
people's income, although the g
was somewhat smaller by the end
the decade (see chart and column
of the table).

Other trends shown in the ta
are: a slow increase in exports (c
umn 7), 17 to 27 million acres a y
withheld from corn production (
umn 9), a slight strengthening
corn prices (column 10), a grad
reduction of governmental stockp
(column 11), and a rapid rise in c
of governmental programs (colu
12).

Although tax money is spent
agricultural programs that h
slightly increased retail food pri
consumers now obtain food at an
time low of 16.5 percent of dispos
income.

Key changes of new Act

1. **Production control for f
grains, wheat, and cotton is b
"set-aside" procedure rather t
reduction of a particular crop.**
viously a participant had to red
his program crop below an establis
base as well as reserve a certain a

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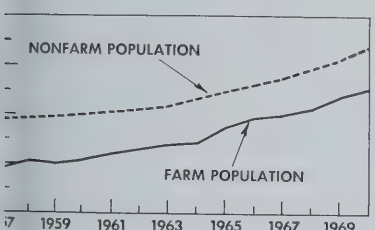
: for conservation use. With the -aside, the amount of land retired conservation remains the same, : the remaining cropland may be ocated as the farmer chooses. nce, he can actually increase the eage of a program crop.

?. Slightly lower price support l slightly higher compensatory ments are likely. Support and ment levels are disengaged some- at from parity. If costs continue rise, these levels will not now in- ase as before. The price support corn is the same for 1971 as for 0. The minimum payment is 32 ts instead of 30 cents a bushel for the participating farmers' normal duction.

. The total payment to any one ner has been limited to $55,000 commodity per year. In 1970 limit would have affected 1,100 ners, most of them cotton pro- ers, and would have saved $58 ion out of a total $3.5 billion.



osable personal income per capita, and nonfarm population, 1957-1970.

4. The target return level per unit for wool producers has likewise been disengaged from parity. It has been set at a maximum level of 72 cents a pound for shorn wool.

5. Dairy products are supported generally. Formerly butterfat was specifically supported.

6. Finally, the federal government was called upon to give more emphasis to rural development.

Anticipated results of changes

Several results can be anticipated from the provisions of the 1970 Agricultural Act, assuming no changes in other economic conditions.

1. Excess production may result from increased producer freedom. Since the set-aside permits farmers to allocate resources to crops with the highest economic return, supplies of wheat and feed grains could become "burdensome." Higher government payments may be necessary to bid away the expanded productivity.

2. Unless public payments are increased, farm income may be lower. There is a trade-off between stricter control of production, less freedom in resource use, producer gains, and minimal public costs on the one hand; and relaxed control, with expanded production, on the other hand. The probable result is either marginally lower product prices (also lower consumer prices) and lower income to producers, or higher Treasury costs to maintain farmers' incomes.

3. Expanded exports are possible. Less production control with weakened prices and price supports could encourage exports. This also depends upon the trading policies of importing countries.

4. The public image of a price-income policy for agriculture may be improved since huge individual payments — sometimes amounting to millions of dollars — will no longer be made. However, the new regulation is not likely to affect either production control or total government costs.

Other implications

The new policy is focused on the commercial farmer. It does not remedy the large differences in farmer income or the problem of the poverty farmer. Nor is it designed to do so. Also left unresolved are problems of adequate education for rural youth who can't find work on the farm; revitalization of the rural community; appropriate farmer bargaining opportunities; and improved food distribution to undernourished people.

The farmer, his leadership, the professional researcher and educator, and the policy-maker have only a short breathing spell before the next round of policy-making begins in two years.

Recent Economic Trends Relevant to Agricultural Price and Income Policy, United States, 1961-1970[a]

	Rate of increase from previous year		Indexes (1957-59 = 100)			Farm exports, includ-ing P.L. 480	Income per farm capita, as % of nonfarm	Corn acre-age with-held	Farm price for corn	Value of govt. stock-pile	Govt. costs, exclud-ing P.L. 480
	Total farm output	Total popu-lation	Prices paid to farmers	Prices paid by farmers	Retail food prices						
	2	3	4	5	6	7	8	9	10	11	12
	pct.	pct.				$bil.	pct.	mil. A.	$	$bil.	$bil.
....	1.1	1.7	99	103	103	5.0	60	19	1.10	7.04	1.76
....	1.1	1.6	101	105	104	5.0	61	20	1.12	6.68	2.44
....	3.3	1.5	100	107	105	5.6	64	17	1.11	7.26	3.43
....	−1.0	1.4	98	107	106	6.3	62	22	1.17	7.10	3.47
....	3.2	1.3	103	110	109	6.2	71	24	1.16	6.39	2.84
....	−1.0	1.2	110	114	114	6.9	75	24	1.29	5.31	1.70
....	4.2	1.1	105	116	115	6.4	73	16	1.03	3.36	2.02
....	2.0	1.0	108	121	119	6.2	73	25	1.08	3.18	3.14
....	2.0	1.0	114	127	126	5.9	76	27	1.16	4.58	4.53
)..........................	−1.0	1.1	116	132	132	7.2	75	26	1.34	4.65	4.13

Sources: Annual Report of the President, 1970, 1971, U.S. G.P.O.; USDA, Foreign Agricultural Trade, May 1971; USDA, Farm Income Situation, July 1971; 1970 Handbook of Agricultural Charts, Ag. Handbook 397; USDA, Feed Situation, May 1971; USDA ASCS "Fact Sheet," February 1971; USDA, "Budget Out-annual.

How Much Formal Schooling Does a Student Need Today?

K. E. GARDNER

DOES A STUDENT really need to spend four years in college to earn his Bachelor's degree? Would three years be adequate? Or should the time be lengthened to five years? These are questions that students and others are now asking the colleges to consider.

Varying trends

The Carnegie Commission recently recommended that the colleges and universities should try to cut a year off the time required for a typical Bachelor's degree. Medical colleges, they suggested, could shave off one year of formal education and one year of post-degree internship work. These recommendations are based on the belief that more education can come on the job or through periods of formal training at a later date, whenever the position demands this training or individuals want it.

The saving in time and in dollar costs of schooling would be considerable were we to chop one year off the traditional four years required for the baccalaureate degree. In British and Continental universities, only three years are usually required for this degree.

Possibly, European secondary schools provide more training in the basic humanities, sciences, grammar, and mathematics than do high schools in the United States. Too, the closer screening of those permitted to go to college may assure a better prepared matriculant in Europe. At the same time, we are aware that our own secondary schools have been upgraded tremendously in the past 15 years. This is apparent in the enlarged capability of students entering the University of Illinois.

Despite the movement toward shortening the time required for a college degree, a trend in the opposite direction is developing in some colleges. Architectural schools are increasing the length of time required for a degree; law colleges are requiring the Bachelor's degree before admission, rather than just three years of college; and some veterinary colleges are moving in the same direction. We have also seen more and more B.S. graduates in agriculture go on for graduate study. Thus, the picture is not entirely clear as to the direction which we shall take.

The picture is complicated by the varying talents, background, and attitudes of students. For the less talented or less well-prepared students, we require or suggest extra course work — two or three rhetoric courses instead of one or none, for example, or an extra course in chemistry or mathematics.

At the same time, the more talented students can do some extra "boning-up" and obtain course credit by examination without actually taking the subject. They thus have the option of graduating in three or three and a half years if they want to, but few of them avail themselves of this opportunity. Nor do many students graduate with any surplus credit hours, although the number and variety of subjects available to them can only be described by the outworn term "fantastic." Perhaps students find enough tensions and pressures in college as it is. Perhaps they want to examine values other than classwork in the university community.

In-service training

Today, we realize more and more that a high percentage of the technical education of a typical man or woman *is* obtained on the job. A cordingly, some of our colleges ha developed what might be called "sto and-go" programs of study, whi permit the student to attend clas for two semesters or several quart and then work on the job for a peri of time before returning to his class By this method he sees the applicati of his learning and notes his sho comings.

Most agriculture students fr farm backgrounds have had a gr deal of such in-service experien mainly in the production areas. I students planning to go into the dustry or business end of agricultu such training may have considera value. Appropriate summer empl ment can also provide excellent perience for young people.

Many Illinois junior colleges p vide in-service training as part their technical programs, althou not in their baccalaureate-orien programs. Some four-year colle now give academic credit, under c tain conditions, for the vocation technical work in junior colleges a even for summer working experie if it has been properly supervised.

A few conclusions

We may draw a few general c clusions relating to the problem saving some of the time and mo spent on post-secondary schooli More of our technical education be obtained on the job; simila much of our cultural uptake can and is achieved through our ind dual efforts as we go through life. ferior students should not be allo to loaf their way through coll Certainly nobody should receiv degree that represents only mo effort. And graduate and professio colleges should select their stud with care.

The two-year junior college, technical school, and the adult e cation program are essential in dients in a sound schooling syst Not everything starts and stops at senior institutions. Not everyone n or should have a college degree.

K. E. Gardner is Associate Dean and Dir of Resident Instruction.

International Programs a Mutual Benefit

W. D. BUDDEMEIER

LMOST from the time that the
ᴸ College of Agriculture opened its
ɔrs, it has been involved in inter-
ional education in a broad sense.
ɔm 1873 through 1968, 255 foreign
dents from 59 countries received
tificates or Bachelor's degrees;
m 1906 through 1968, 651 re-
ved M.S. or Ph.D. degrees. For
ny years, also, individual staff
mbers have had informal working
tionships with professional col-
gues in foreign institutions.

Vhile these informal arrangements
tinue, most of our overseas ac-
ties since 1955 have been more
nal, having developed through
tracts with the U.S. Agency for
ernational Development. The ma-
objective of our technical assis-
ce contracts with USAID has been
assist less-developed countries in
r agricultural and economic de-
pment, with special emphasis on
cultural universities.

n recent years an additional dimen-
has been added to international
vities. This is the development of
College of Agriculture and the
versity as a whole through over-
programs. It might be called the
-off" or "feedback" resulting from
seas experiences of faculty mem-
and students.

hus there has been a sort of tran-
n of international involvement. It
ed with accepting foreign stu-
s in the College of Agriculture.
xpanded over the years as numer-
individual staff members became
lved in programs with foreign in-
tions and professional colleagues.
r World War II, international
rams supported by the U.S. gov-
nent and other agencies became
e formalized in an effort to assist
war-devastated and developing
ntries. More recently there has
a transition to a concept of mutually beneficial cooperation rather than of assistance. Research is the means by which this concept is most easily realized.

. Buddemeier is Associate Dean and Di-
of International Agricultural Programs.
also Professor of Farm Management.

Kinds of international research

International cooperative research may take several forms. A foreign student may return to his home country to do research under the supervision of a University of Illinois staff member. A U.S. student may do doctoral dissertation work abroad on a problem of interest both at home and in the country where he is working. Or a faculty member — sometimes with his students — may cooperate with overseas counterparts on research that is significant to the countries involved.

Such research projects can pay off in a number of ways. For example, it was by work abroad that our entomologists discovered an insect predator of a serious insect pest in the United States. Continuing research abroad may pave the way to introducing the predator into this country.

One faculty member's short period of service overseas gave impetus to the efforts of our food scientists to develop various low-cost, nutritious foods from soybeans. This project may be of incalculable importance to the market for soybeans as well as to the problem of improving human nutrition at home and abroad.

Another potential benefit lies in the work of the agricultural economists. Through studying problems of economic development abroad, they should gain new insights into problems of the United States. Many other examples could also be cited of potential benefits to our economy and living standards resulting from international cooperative research.

Campus teaching benefits

A benefit which cannot be easily measured but which is immensely important is the enrichment that a faculty member brings to his work on campus after he has returned from overseas service. He is better able to see problems in a world framework instead of in terms of the state or the nation only. Also, his wealth of material and experiences can be used to vitalize his teaching.

A substantial number of college students today have had international experiences of one kind or another. These run the gamut from purely pleasure travel to required military service. In between these extremes, young people have been able to take advantage of a wide variety of opportunities — a year of study abroad, educational tours, service in the Peace Corps, and participation in International Farm Youth Exchange and Teen Caravan programs, as examples.

Whether college students have traveled abroad or not, growing numbers of them are adopting an international viewpoint. As students become more worldly-wise, it is essential for the University to do likewise. Rigidly provincial and isolationist viewpoints not only are unacceptable to many students, but are also unrealistic in world politics and economics today.

Although "involvement" is an overworked word today, it is still relevant to the international dimensions of a great university. Involvement in international activities is the best way for a faculty member to study and teach about world problems, whether they be agricultural, social, political, or economic.

It is the responsibility of the university to prepare people for citizenship. In a world which is rapidly shrinking as a result of dynamic developments in transportation and communication, "world citizenship" cannot be ignored. Isolation is no longer worthy of serious thought. World problems must be recognized, understood, and attacked through education and cooperation.

FARM BUSINESS TRENDS

GREAT CHANGES have occurred since the corn situation and outlook were reviewed on this page last winter. At that time several reasons for the short corn crop in 1970 were listed. Prospects for 1971 were very uncertain, ranging from three-fifths of a crop to a record-breaker. Four favorable factors were listed against one big danger.

All of the favorable factors developed as expected: (1) Blight-resistant seed was used to better advantage. (2) Farmers in the eastern corn belt states got their crop off to a much better start. (3) The western edge of the corn belt suffered less from drouth. (4) Weather conditions were much less favorable for the blight than in 1970.

The "big danger" did not materialize: only a relatively few blight spores survived the winter in the corn belt, and the early attack on corn was much less destructive than was feared.

One other development added considerably to corn production in 1971: The USDA changed the Feed Grain Program so that farmers increased corn acreage by 12 percent. Biggest increases were in the northern and western parts of the corn belt. Illinois farmers expanded their corn acreage only 2 percent, because they were badly burned by the blight in 1970.

With the advantage of hindsight, one may conclude that it was a mistake to increase corn acreage in 1971. But when USDA officials and farmers made their decisions, the threat of extensive damage by the blight was quite serious.

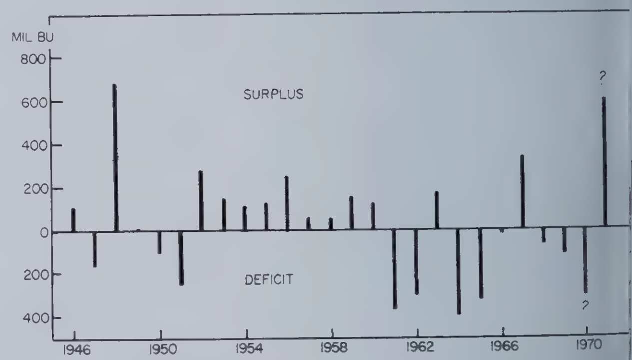
There is still some uncertainty about the size of the 1971 corn crop. But on the basis of conditions reported the first of October, the USDA estimated production at 5,400 million bushels. This is 31 percent more than the short 1970 crop, and 13 percent more than the previous record crop harvested in 1967.

Needs for domestic use and exports during the 1971-72 marketing year are expected to be around 4,700 million bushels (300 million more than last year). Thus the crop exceeds prospective needs by about 700 million bushels.

Only once before has such a large surplus been produced. That was in 1948, when farmers harvested about 3,300 million bushels, and only 2,600 million bushels were utilized. The excess that year was 700 million bushels.

Many farmers will use the Government's loan program to support prices. Loans are available at $1.0[illegible] per bushel, national average. A premium of up to 2½ cents a bushel will be allowed for top quality corn.

If farmers place enough corn under loans, say 800 to 900 million bushels, the resulting shortage of "free" corn should lift prices 10 to 15 cents over the support level by next summer. — *L. H. Simerl, Professor of Agricultural Economics*



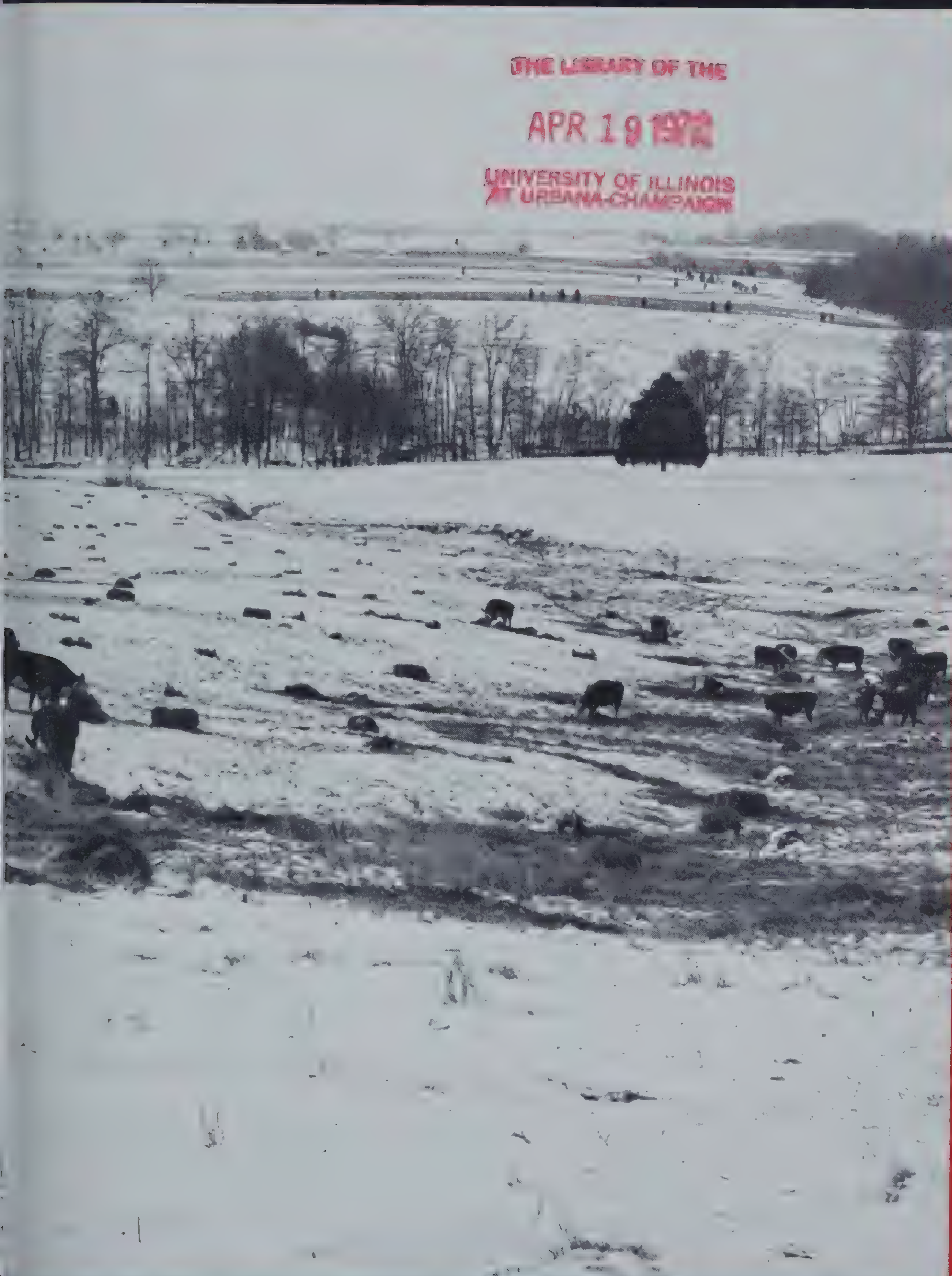
Surplus or deficit of corn production in relation to utilization, 1946-1971.

UNIVERSITY OF ILLINOIS · AGRICULTURAL EXPERIMENT STATION
Urbana, Ill. 61801 · G. W. Salisbury, Director · Publication · 13M

Winter, 1972

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station



IN THIS ISSUE

Ruminants can utilize both traditional forages and crop residues to help meet the world's food needs (page 14).

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE Volume 14, Number 1

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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CONFERENCE ON ENVIRONMENTAL QUALITY

AGRICULTURE AND ENVIRONMENTAL QUALITY — what are the c- tions?" was the theme of a conference at Allerton House ne Monticello, December 12-14. Sponsored by the Council on E- vironmental Quality of the Illinois Agricultural Experiment S- tion, the conference brought together scientists, producers, natur- ists, concerned citizens, and representatives of state and fede agencies.

Purpose of the meeting was to inform participants of (1) t complex interrelationships between food production, population, a environmental quality; and (2) the role of agricultural research society. William Erwin spoke on the first of these topics; Jam Hildreth, on the second. With these presentations as an introductio members of the Council's task forces presented accomplishments the past year and plans for the future.

One half day was devoted to progress reports on the biggest search project undertaken by the Council: Nitrogen as an Enviro mental Quality Factor — Technical, Social, and Economic Co siderations. In spite of all the research that has been conducted nitrogen both here and elsewhere, relatively little is known ab its movement and possible effects.

Other reports were given on Animal and Human Metabo Wastes; Pesticides and Pest Control Systems; and Erosion and Se mentation. The task forces concerned with Wood Residues and Fo Processing Wastes presented their research accomplishments means of a display showing products made from and uses for so waste materials.

With our present techniques and knowledge, we can begin learn how to eventually control most, though not all, environmen problems. The techniques for studying human interaction with en ronmental quality are not so readily available. Two task gro dealt with this subject, presenting a movie and slide sets that h been developed to increase awareness of the problem.

The final half-day session began with an address by Sena Charles Percy, speaking on Legislative Implications at the Fede Level. Representatives of six interest groups then presented th views on the following topics: Agricultural Chemicals, Agricultu Processing; Concerned Citizens; Regulatory Agencies; Farmers Their Concerns and Worries; and The Natural Environme — *R. J. Miller, Associate Director, Agricultural Experiment Stati*

ɅIore Nutrients Are Added to Soil 'han Are Hauled Away in Crops

I. WELCH

:ss THAN 10 years ago, more nu-·ɪ trients were being removed from I nois fields than were being added. ˹day exactly the opposite is true. ˹is reversal has shown up in a s dy of nitrogen, phosphorus, and ɪassium added to and removed f m the soil between 1940 and 1970.

\dded nutrients were considered t be only those applied to the soil a ertilizer. They did not include nu-t nts from other sources, such as l umes, manure, and sewage sludge. ɅO, rock phosphate was not included v h added phosphorus.

Nutrient removal is reported as t nutrients harvested in seven agro-n nic crops — corn, soybeans, wheat, o s, barley, rye, and alfalfa hay. The p nds of nitrogen, phosphorus, and p assium removed in each harvested u t (bushel or ton) are given in I ɔle 1. To calculate how much of e h nutrient was removed by a par-ti lar crop, the nutrient content per h vested unit was multiplied by the t l units produced in Illinois. For e mple, bushels of corn production n ltiplied by 0.90 gives the pounds o nitrogen removed in corn grain. T pounds of a given nutrient re-n ved by the different crops were a ed to determine total removal of t nutrient.

Welch is Professor of Soil Fertility, De-p nent of Agronomy.

Crop harvest does not, of course, account for all the plant nutrients removed from the soil. For example, they may be lost by erosion and leaching, or they may escape in gaseous form. Also, some fertilizer is added to or removed from Illinois soils by fruits, vegetables, grasses on lawns and golf courses, and other plants not included in my calculations. However, the seven crops that were included in the study probably account for more than 95 percent of the fertilizer usage in Illinois.

Added vs. removed

In 1940, harvested crops removed 220,000 more tons of nitrogen than was added as fertilizer (Fig. 1). In 1969, crops removed 141,000 tons less than was added. (I have used 1969 rather than 1970 in this and the following comparisons because of the reduction in corn yields due to blight in 1970.)

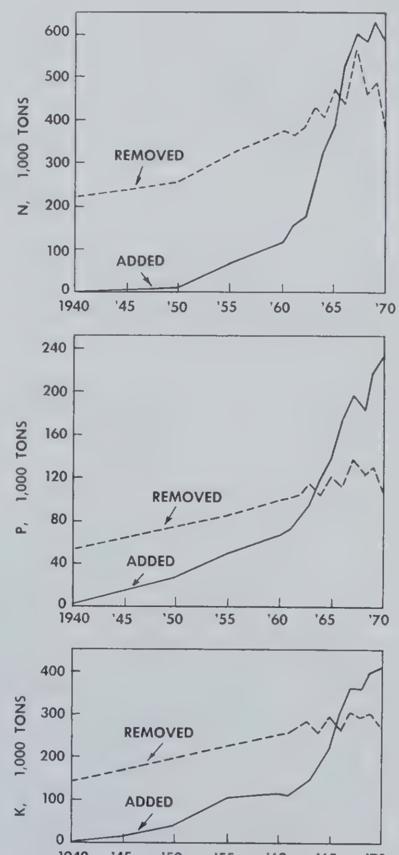
Phosphorus and potassium followed much the same pattern as nitrogen (Fig. 1). In 1940, 53,000 more tons of phosphorus was removed than was added; in 1969, 88,000 tons less was removed than was added. Potassium removal exceeded additions by 145,-000 tons in 1940; it was 93,000 tons less than additions in 1969.

The magnitude of the change that has occurred in the last 30 years is brought out more dramatically if we express added nutrients as a percentage of removed nutrients (Fig. 2). The amounts of added nitrogen, phosphorus, and potassium were, respectively, only 1, 5, and 3 percent of the amounts removed in 1940 — as compared to 129, 167, and 130 percent in 1969.

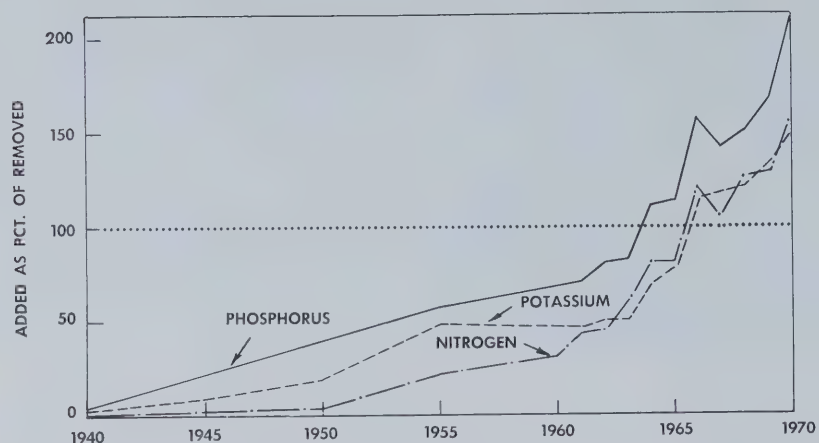
Nutrients in the Harvested Portion of Seven Crops

Crop	Nutrients harvested, lb./unit		
	N	P	K
Corn grain, bu..........	0.90	0.15	0.20
Corn silage, T..........	6.67	1.16	5.40
Soybeans, bu..........	...[a]	0.36	1.16
Wheat, bu..........	1.25	0.25	0.20
Oats, bu..........	0.65	0.11	0.16
Barley, bu..........	1.10	0.18	0.30
Rye, bu..........	1.09	0.22	0.31
Alfalfa hay, T..........	...[a]	5.83	37.50

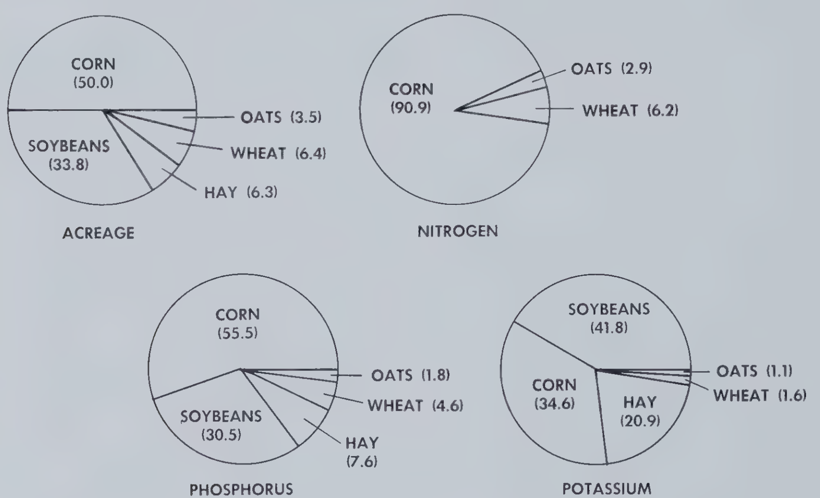
[a] These fix nitrogen by bacterial action. Little fertilizer N is added to them.



Amounts of nitrogen, phosphorus, and potassium added to and removed from Illinois soils, 1940-1970. (Fig. 1)



Additions of phosphorus, nitrogen, and potassium as percentages of amounts removed. At 100 percent, additions and removals are in balance. (Fig. 2)



Percentage of acreage and of nitrogen, phosphorus, and potassium removal accounted for by major Illinois crops. (Fig. 3)

Even in 1960, fertilizer additions of nitrogen, phosphorus, and potassium were, respectively, only 31, 68, and 47 percent as much as the amounts removed in harvested crops. Comparing these figures with the 1969 percentages, we can see that the fertilizer picture in Illinois has changed greatly in just the last 10 years.

Fertilizer phosphorus has exceeded the amount removed in every year since 1964. Nitrogen and potassium additions began exceeding removals in 1966 and have continued to do so ever since.

Before 1964, the soil was being "mined" of phosphorus; and before 1966, it was being "mined" of potassium. Nevertheless, one cannot categorically say that less than economically optimum rates of fertilizer were being used during the long period that more nutrients were removed from Illinois soils than were added. Possibly the soil could supply some or all of the nutrients that were removed by crops.

On the other hand, one cannot dogmatically say that more than economically optimum rates of fertilizer have been added in recent years. Some of the added phosphorus and potassium may become chemically unavailable for plants, and, as mentioned earlier, some nutrients may be removed from soils in other ways than by crop harvest.

The optimum amounts of fertilizer that should be added in Illinois can be determined only by research. Such research is being conducted at seve[ral] locations in the state.

Even though we cannot say th[at] we are using too much fertiliz[er,] most agriculturists would agree th[at] nitrogen, phosphorus, and potassiu[m] probably limit crop production l[ess] today than 5 years ago. Furth[er]more, the fertility status of Illin[ois] soils must be increasing, since ad[di]tions have been exceeding remova[ls.] This trend should be reflected [in] higher soil tests for phosphorus a[nd] potassium today than 5 years ago.

Removal by different crops

Figure 3 shows the acreage of t[he] five major crops and the nutrie[nts] they removed, as percentages of t[he] totals, in 1969. Barley and rye we[re] not included as the two together a[c]counted for less than 0.2 perc[ent] of the acreage and the nutrie[nts] removed.

Corn accounted for more than [90] percent of the nitrogen removed, [al]though it occupied only 50 perc[ent] of the acreage planted to the f[ive] crops. Thus most of the nitrog[en] hauled from Illinois fields is in t[he] form of corn. (Soybeans and h[ay] were omitted from the calculati[on] for nitrogen, since legumes produ[ce] their own nitrogen and receive lit[tle] fertilizer nitrogen.)

The curve for nitrogen removal [in] Figure 1 closely reflects total co[rn] production. Large amounts of nit[ro]gen were removed in 1967, when [we] had a record corn crop. Nitrogen [re]moval greatly decreased in 1970 b[e]cause corn production was lowered [by] southern corn leaf blight. Judgi[ng] from early corn yield reports, mu[ch] more nitrogen was removed in 19[71] than in 1970.

The percentage of total phospho[rus] removed by the various crops w[as] fairly close to the acreage perce[nt]ages. The percentage of potassium [re]moved by the nonleguminous gr[ain] crops (corn, wheat, and oats) w[as] considerably less than their acrea[ge] percentages. The opposite was t[rue] of soybeans and hay.

Corn and soybeans are the pr[in]cipal crops in which all three nu[tri]ents are hauled from the field tod[ay]

Three Fungi That Can Reduce Soybean Yields

J. B. SINCLAIR and L. E. GRAY

As SOYBEANS are grown more intensively in Illinois, growers, ›xtension workers, and research plant ɔathologists must be ever watchful 'or signs of plant disease.

A host of plant pathogens are ːnown to attack soybeans, but right ıow only three fungi appear to have he potential for inflicting significant osses in Illinois. These are *Cephalosporium gregatum,* the cause of ɪrown stem rot disease; *Macrophonina phaseoli,* which causes charcoal ot disease; and *Diaporthe phaseolorum* var. *sojae,* the cause of pod and tem blight disease. *Macrophomina* p. and *Diaporthe* sp. are seed-borne. 'he exact role of these three fungi nd the amount of damage they ause to Illinois soybeans are still bscure.

The visual symptoms produced by ıese pathogens are most evident at ıe end of the growing season. Howver, the authors have observed durıg routine surveys and by laboratory olations that one or more of these ıngi can infect plants early in the ›ason.

Although early infection may not esult in conspicuous symptoms, it ıay weaken the plants and even ll them. The seriousness of early ıfections was indicated by stand ounts in experimental fields in 1971. ccording to counts made 2 weeks ›fore maturity, 20 to 70 percent ' the plants in the different fields ıd died since complete seedling nergence.

Infected plants that survive un- harvest may appear to be only ghtly shortened, or somewhat unrifty when compared to noninfected ants. However, plant weight is duced, along with seed size and ›ight. Thus these pathogens, alone in combination, may reduce stands, suppress yields, and affect seed quality.

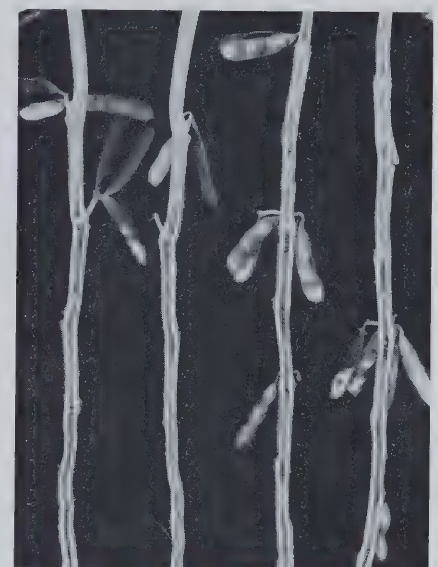
Mean Seed Yields of Soybean Plants Without Brown Stem Rot and With Two Degrees of Stem Browning

Degree of browning	Part of plant: Upper half	Lower half	Total plant
	Yield in grams		
No browning	15.1	20.5	35.6
Browning to 15 cm	14.3	18.7	33.0
Browning of entire stem	11.0**	15.8**	26.8**
Least sig. diff. at .01% level	2.9	3.1	5.1

** Significantly lower at the .01-percent level.

Brown stem rot (*Cephalosporium gregatum*) occurs every year in Illinois soybean fields. Plants are infected at about 7 to 8 weeks of age. Browning develops to different heights on the stems of infected plants. Only plants with browning throughout the entire length of the stem were found to have a significant yield reduction (see table above).

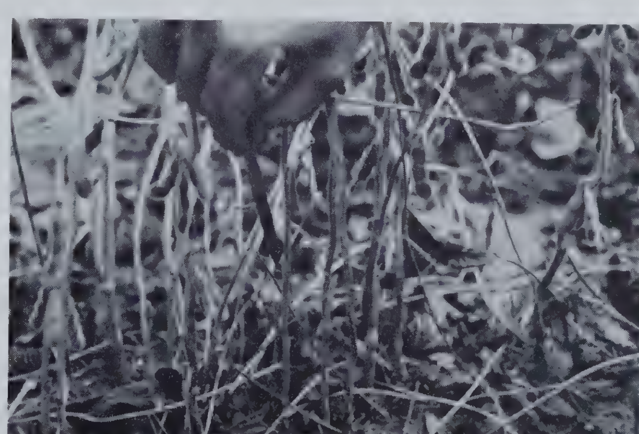
Macrophomina charcoal rot was reported to occur only in soybeans growing in sandy soils of the United States. However, in 1971 it was found in every one of 10 Illinois fields surveyed for the disease, and the fungus was isolated from the roots of all plants collected from these fields. Infected plants were unthrifty and weak.



Split stems of maturing soybean plants showing symptoms of infection by *Cephalosporium* sp. (two at left) and by either *Macrophomina* or *Diaporthe* sp. (two at right). Two plants at left show discoloration in lower part of stem, but no pith breakdown. Plants at right are discolored throughout stem and pith has broken down. (Fig. 1)

Diaporthe pod and stem blight has received very little attention, but it was prominent near the end of the growing season in almost every field surveyed.

As yet no resistant varieties have been developed.



Soybean plants infected with *Macrophomina* sp. (indicated by pencil) are smaller than the noninfected plants growing around them. (Fig. 2)

B. Sinclair is Professor of Plant Pathology; E. Gray, Research Plant Pathologist, ARS, DA, Soybean Investigations, Regional Soyın Research Laboratory.

Double-Crop and Play Summer Roulette

Interplanting soybeans in wheat can pay off if you have the right combination of good luck and good management

J. E. DILLON and G. E. McKIBBEN

MOST ILLINOIS grain farmers concentrate their time, energy, and knowledge on producing a single crop on a given field during a specific growing season. This is especially true for farmers in the central and northern parts of the state.

Recently, however, improved agricultural technology has enabled some farmers to produce two crops on the same land area during a single growing season. This practice, referred to as double-cropping or multi-cropping, is best adapted to farms where a small grain crop is grown. The small grain is harvested in late June or early July and the following crop is usually planted in the stubble. Planting a second crop makes more efficient use of the entire growing season.

Many problems exist

Several conditions can reduce the chances of successful double-cropping. Drouth is probably the major cause of failure in many non-irrigated double-cropping systems. Unless adequate rainfall arrives during July and August, the second crop may be low-yielding or fail completely.

Weeds and frost damage to the second crop are other major problems associated with double-cropping. For these reasons, timeliness in establishing the second crop is important. If too much time elapses between removal of the first crop and seeding of the second, weeds can germinate and become well established. When soybeans are planted after wheat in northern regions, they may be more likely to be damaged by frost than by drouth. In a double-cropping system consisting of two corn silage crops, the first crop may be damaged by frost, since it must be planted early.

Planting the second crop may be a problem without adequate equipment. Most farmers who have successfully double-cropped use no-till planters. These planters permit farmers to plant directly into the stubble of the first crop with a minimal amount of soil or straw disruption. Plowing or disking stubble fields during the hot, dry part of the summer tends to increase moisture loss from the soil and reduces the chances of obtaining good second-crop stands.

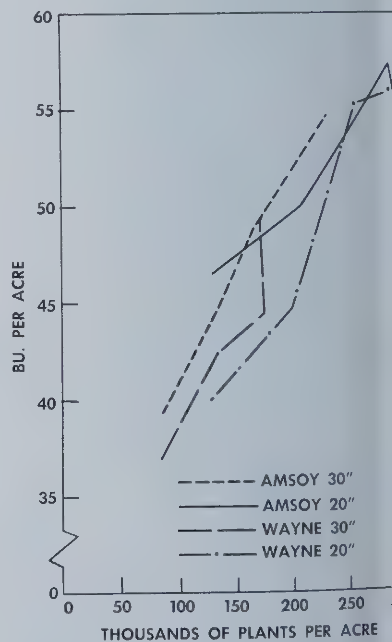
Ways to minimize risks

There are several ways of minimizing the risks of double-cropping. First, a good first-crop stand which has been adequately fertilized is important. This increases the chances of obtaining high first-crop yields and aids in the control of weeds.

It's essential to remove the first crop early and get the second one started right away. Immediate establishment of the second crop is necessary since the first crop canopy has helped prevent excess moisture evaporation from the soil. This moisture can be utilized by the second crop seed for germination and early growth. Early establishment of the second crop also reduces the probability of frost injury before maturity.

Weeds must be controlled in both crops. Because weed control by cultivation is impractical in the second crop, a preemergence herbicide should be applied to control anticipated weeds. Since some weeds are usually present in the first crop, a contact herbicide should also be used. Wee in the second crop are very damagi because they compete for moistu and nutrients during the hottest a driest months of the summer.

The use of improved cultural pra tices and varieties is also importa In experiments with Wayne and A soy soybeans at Dixon Springs, re tively high plant populations in bo 20- and 30-inch rows were more pr ductive than low populations (F 1). This may have been due the tendency of late-planted soybea to be short. Narrow rows with hi populations provide more rapid a complete between-row canopy cov



Yields of Wayne and Amsoy soybe planted in wheat stubble July 10, 19 Each variety was planted in 30- and inch rows and at four plant populatic Yields are averages of two herbici treatments. (Fig.

J. E. Dillon is Associate Agronomist at Urbana-Champaign; G. E. McKibben is Associate Professor of Agronomy, Dixon Springs Agricultural Center.

y planting wheat in two 8-inch rows
en skipping two rows, room was left for
rilling soybeans in 32-inch rows the
ext spring. (Fig. 2)

ge than the wider rows and lower
opulations. This canopy helps retard
eed growth and enables the crop to
ore efficiently utilize late summer
oisture and light.

Moisture is the most necessary con-
ition for successful double-cropping.
uring years when rainfall is plenti-
l, second-crop soybeans have yielded
) to 50 bushels per acre. *Dry years
ay produce no second crop.*

orthward movement

Within recent years, double-crop-
ing has been gradually moving
orthward for at least five reasons:
) The development of the no-till
anter has permitted second-crop
edings under trashy field conditions.
) Improved harvesting equipment
as made it possible to remove the
st crop at high moisture levels with
ss grain damage. (3) Associated
ith the harvest of high-moisture
ops is the more widespread use of
ain driers. (4) More vigorous hy-
ids and varieties have been devel-
ed. These get off to a faster start
d are usually more resistant to
sease. (5) Earlier maturing hybrids
d varieties have been developed.

Even though these factors have im-
oved the chances of growing two
ops in one season in northern areas, this practice may still frequently be unsuccessful because of the short growing season. A double-cropping technique that may help reduce this risk is the interplanting of the second crop into the first. This system is mechanically complicated and may reduce yields of the first crop, but it has the advantage of permitting the second crop more time to develop and mature.

Interplanting experiment

An interplanting experiment, based on previous research by J. W. Pendleton, was conducted on the Agronomy South Farm at Urbana during the fall of 1967 and spring of 1968. Arthur soft red winter wheat was seeded in 8-inch rows in small experimental plots in the fall. On some plots, two rows were skipped, then two rows planted, and so on (Fig. 2). Skipping two wheat rows at a time permitted interplanting of soybeans the following spring, with two rows of wheat and one row of soybeans being grown every 32 inches.

The following spring, soybeans were interplanted in different wheat plots on two dates — May 4 and June 6. On these two dates, also, soybeans were drilled in 32-inch rows on plots with no wheat, and on July 17 soybeans were drilled in wheat stubble. Some of the wheat plots with skipped rows were not planted to soybeans.

Where two out of four 8-inch wheat rows were skipped and no soybeans were planted, wheat yields were 37 bushels an acre as compared to 54 bushels on solid-drilled wheat plots (see table). Thus, decreasing the wheat stand by 50 percent reduced yields by only 31.5 percent. This percentage, however, may vary from season to season.

When soybeans were interplanted into the skipped areas, wheat yields were reduced by only 1 more bushel — from 37 to 36 bushels per acre. This was true whether soybeans were planted on May 4 or June 6, suggesting that soybean plants compete very little with wheat during early stages of growth. However, when soybean yields were compared, the later interplanting date produced 5 more

Wheat and Soybean Yields, Interplanting Experiment, 1968

Treatment	Wheat yields	Soybean yields
	bu./A.	bu./A.
Wheat solid-drilled, 8″ rows	54	..
Two 8″ wheat rows; skip two rows	37	..
Soybeans drilled, 32″ rows (May 4)	..	54
Soybeans drilled, 32″ rows (June 6)	..	46
Two 8″ wheat rows; soybeans interplanted (May 4)	36	35
Two 8″ wheat rows; soybeans interplanted (June 6)	36	40
Soybeans drilled in wheat stubble (July 17)	54	Frost-killed

bushels per acre than the early date. This suggests that soybeans can be interplanted too early for maximum production. Also, with early interplanting dates, the soybeans would usually become tall enough to impede wheat harvest.

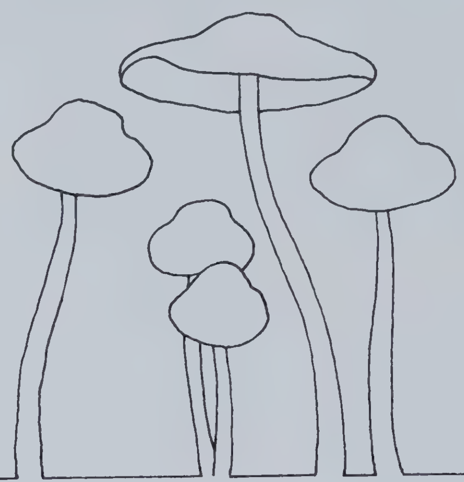
Soybeans planted alone in 32-inch rows on May 4 and June 6 yielded more than soybeans interplanted on the same date. Unlike the interplanted soybeans, soybeans grown alone and planted on May 4 yielded more than the soybeans planted later. Soybeans planted in wheat stubble frosted before maturity.

According to these data, the best double-cropping interplanting system produced 36 bushels of wheat and 40 bushels of soybeans per acre. Economically, this system resulted in more profit than growing wheat alone; it was not equal to growing soybeans alone because double-cropping involves more labor and expenses.

Double-cropping not for all

Double-cropping should not be considered as a replacement for a full-season soybean crop. It may have a place on farms where a small grain crop is to be grown. But even on these farms, double-cropping should not be attempted without the proper equipment and a high degree of managerial ability.

Successful double-cropping does not happen by accident. It is a game of "summer roulette" which can be won only when all conditions are favorable.



The Mysterious Fairy Rings

R. F. FISHER

On warm humid days in late summer, many mysterious dark green rings appear on lawns and golf courses throughout Illinois — and in various other parts of the world as well. For centuries, many people firmly believed that these "fairy rings" were due to the nighttime dancing and other festivities of leprechauns, elves, and fairies. And who, indeed, could better make a green ring on your lawn than an impish, kelly green leprechaun?

Evidently the "little people" keep returning to the same places for their festivities, bringing more and more of their friends every summer. A ring may reappear in the same spot year after year, but each summer the diameter will be larger than it was the year before. The rings can be anywhere from 3 to 9 inches wide, and the areas they encircle can vary from a few inches to 30 feet in diameter.

Various fungi are cause

Some years ago modern scientists, determined to remove the mystery and possibly even the joy from life, found that fairy rings are caused by a wide variety of fleshy fungi. Certainly some readers have observed the mushrooms which generally appear a few days or weeks after the green color, and which are the fruiting bodies of the fungal plant growing beneath the soil surface.

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Many of the mushrooms are white to light beige and are large enough to be easily spotted from a passing car. They may also last for as long as several weeks. Others, however, are small, brown, and so ephemeral that they may go completely unnoticed.

Several hypotheses as to how these fungi accomplish the feat of making grass greener have been put forth. However, for some time it appeared as though the leprechauns might be responsible for the color and the toadstools as well.

Soil under rings is studied

My interest in fairy rings was aroused during a study of fungi in forested soils. The object of the study was to determine whether the large numbers of fungi associated with forest stands might cause forested soils to differ from other soils. It seemed that the soil happenings beneath the fairy rings might provide a clue to this problem.

If one were to observe a ring for several weeks, he would notice the following sequence of events: (1) A dark green ring shows up in the grass. (2) A week or two later, the fungal fruiting bodies (mushrooms) appear in the ring. (3) Later the grass almost stops growing and tur yellow.

In an effort to better understar why these events occur, we sampl the soil surface underneath a numb of fairy rings, as well as the soil i side and just outside of the rin Samples were taken at the height the green coloration and also seve weeks later, when the growth of gr in the ring was severely diminish and the ring was more yellow-gre than the surrounding grass.

The samples were analyzed f soluble nitrate (NO_3^-), ammoni (NH_4^+), and easily extractable ph phorus (P). Presumably these an yses indicate the quantities of t important nutrients — nitrogen a phosphorus — that are available the grass.

The data in Figures 1 and 2 rep sent the averages from nine differe rings of *Marasmius oreades* (Bo Fr. This species, commonly known the fairy ring mushroom, is the o most often associated with the pl nomenon.

Nitrogen increases

During the height of the gre coloration, the soil under the ri contained much more ammonium trogen than the soil either inside outside the ring (Fig. 1). This a cumulation of ammonium was due

he hyphae of the fairy ring mush-
oom.

Inspection of the soil beneath the airy ring revealed a large concentra- ion of these hyphae, which look like ine white roots. Although we see hem much less often than the fruit- ng body (mushroom), the hyphae nake up the major portion of the ungal organism.

The fungus derives food from dead rganic material, and the hyphae are esponsible for gathering this food rom the soil. To accomplish this, the yphae excrete many complex sub- tances known as enzymes. One or nore of these enzymes are capable of mmonification — that is, they can ree ammonium from complex or- anic compounds found in the soil rganic matter.

Many other microorganisms are lso capable of ammonification. They re responsible for the ammonium evels in the normal soil outside the iry ring, as shown in Figure 1. The dditional stimulation that the fairy ng enzymes give to ammonification ccounts for the ammonium peak nderneath the rings.

There is a much smaller increase the quantity of nitrate available grass in the ring. The fungus prob- bly does not directly stimulate the roduction of nitrate, a process called trification. However, almost every il contains organisms that can con- ert ammonium to nitrate. Appar- tly, the small increase in available trate in the ring is due to the larger antity of ammonium for these or- nisms to convert.

osphorus

Unlike nitrogen, phosphorus in the il may come from inorganic sources. many soils, however, a good deal the phosphorus exists as a constit- nt of complex organic compounds. large number of microorganisms d in converting organic phosphorus o available phosphorus. This helps account for the phosphorus content the soil outside the ring.

The fungal hyphae under the ring crete enzymes which greatly in- ase the conversion of organic phos- orus to available phosphorus. This explains the peak in available phosphorus in Figure 1.

Intense activity unique

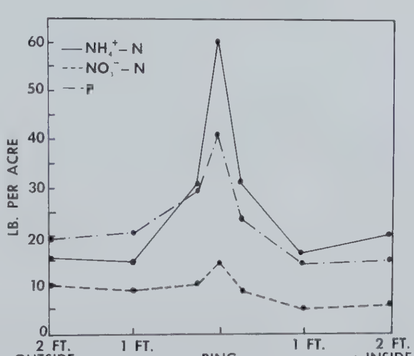
The fungi that form fairy rings are not unique in their ability to increase the rate of ammonification, the availability of phosphorus — and the availability of other nutrient elements as well. We have known for over a decade that many fungi possess this ability. What is unique about the fairy ring-forming fungi is that they concentrate this ability into a small area of soil and operate intensively for a short period of time.

Although nearly all soils contain some fungi, forested soils contain many more than grassland or agricultural soils. However, the density of fungal hyphae in the soil beneath a fairy ring is many times greater than the hyphal density in any forest soil.

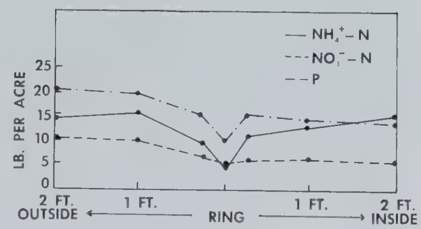
This tremendous concentration of hyphae and the short period of furious activity allow the fairy ring fungi, using quite normal powers, to produce an observable anomoly. There is little wonder, then, that in former times people ascribed this phenomenon to the supernatural.

After the mushrooms die

Shortly after the mushrooms fade and perish, the grass in the ring turns yellow-green and often appears rather sparse. As shown in Figure 2, the very active fungal growth and accompanying release of nitrogen and phosphorus just before the fruiting of the fungus has drastically depleted the



Available nitrogen and phosphorus in soil under, inside, and outside of a fairy ring at height of green coloration. (Fig. 1)



Available nitrogen and phosphorus in soil under, inside, and outside of a fairy ring about one month after the height of green coloration. (Fig. 2)

organic nitrogen and phosphorus beneath the ring. The depleted level of organic nitrogen and phosphorus is not enough to support the rate of nutrient liberation occurring in the normal soil about the ring. Thus the grass in the ring has gone from feast to famine, from lush green to sparse yellow.

Still a mystery

One mystery remains: Why does the fungus grow in an ever-increasing ring? Why not a solid circle or just an irregular blotch?

Probably the fungus starts as a very small circular patch, with a small ring developing around this patch the following season and still larger rings in subsequent years. However, this still doesn't explain why the rings should increase in size every year.

One possible explanation is that the depletion of food and nutrients under the old ring would cause the fungi to move outward each year, forming a new ring. This hypothesis may well provide part of the explanation for the phenomenon. As shown in Figures 1 and 2, ammonium, nitrate, and phosphorus levels are somewhat lower inside than outside the ring.

However, it now appears that the great mass of fungal material in the ring may produce chemical substances which linger in the soil and inhibit the growth of future generations of fungi. This has not yet been conclusively shown for fairy ring fungi, but it has been demonstrated for other species. It will take more research, but in the near future we may have the answer to the final mystery of the fairy ring.

Veterinary College Starts a New Campus

A. G. SCHILLER and T. W. RATHGEBER

MORE STUDENTS can be trained in veterinary medicine, more animals can be treated, and more research can be conducted since the first three buildings on a new veterinary campus were completed last spring. Even with the new buildings, however, it will be some years before the College of Veterinary Medicine can reach its goal of accepting 135 new students each year.

The College of Veterinary Medicine at the University of Illinois is one of only 18 in the nation. It was established in 1947, veterinary medicine having previously been a department in the College of Agriculture.

Space always a problem

When the college began, its offices and classrooms were located in a former sorority house and its clinics, in a renovated cattle barn that had been built in 1904. Even though the initial class was small, consisting of only 24 students, the shortage of space was immediately serious. More room was needed not only for teaching but also for extension work and for research, which the College of Veterinary Medicine continues to conduct as part of the Agricultural Experiment Station.

The problem was partly alleviated by construction of a Basic Sciences Building in 1952 and a Large Animal Clinic in 1955. The Small Animal and Ambulatory Divisions remained in the old beef barn, a considerable distance from the rest of the college.

Even though the new Large Animal Clinic somewhat relieved the overcrowding in the beef barn, the space for the Small Animal Clinic was still inadequate. The decision to build a new facility was made in 1960. Before construction was begun, however, a planning committee was called upon to develop a master plan for the entire college.

The goal was to eventually have all the veterinary buildings on one campus. There wasn't enough room for a new Small Animal Clinic next to either the Basic Sciences Building or the Large Animal Clinic. It was therefore decided to establish a new veterinary campus on the University farms.

Three new buildings

Last April, after numerous construction delays, the first buildings on the new campus were dedicated. These included not only a Small Animal Clinic, but also a Large Animal Surgery and Obstetrics Building and a heating and cooling plant.

The primary goal of the new complex is to provide improved education for larger veterinary classes. However, the clinic is also a valuable referral point for practitioners throughout the state. In addition, the new facilities will be used for research, extension, and continuing education programs.

The Small Animal Clinic is the largest building. With over 53,000 square feet of floor space, the new clinic is nearly six times larger than the old one. The ground floor accommodates the small animal medical and surgical, outpatient, and radiology activities. Space is also provided for the ambulatory clinic and clinical pathology services.

The second floor is occupied by the administrative office for the clinical department, a reference room, and offices for the college extension and preventive medicine divisions. In addition, living quarters are provided for eight resident interns. The basement is utilized for instruction in beginning surgery and medicine, research, and locker space.

Many features of the new clinic rival those in some of the best hospitals. A number of innovations will provide more efficient teachin and communication. These includ a pneumatic tube system for trans-ferring records, drugs, and clinica pathology samples throughout th building; an automated chemistr unit capable of performing 3,00 tests a day; an automated film pro-cessor; a remote station of th University computer system; and a addressograph plate system for recor identification.

The Surgery and Obstetrics Build-ing will be used for teaching larg animal surgery and obstetrics and fo fertility research. Box stalls, bull pen semen collection facilities, refrige ated storage space, and an instrumen preparation and sterilization labora tory are provided for the study o bovine fertility problems. Equipmen for teaching beginning surgery in cludes a large hydraulic operatin table for equine surgery and space fo student surgery tables. A special re covery room, padded to prevent in jury, has been provided for larg animals that have had surgery.

A separate heating and coolin plant had to be built because th campus is beyond the reach of th University system. The veterina plant has a specially controlled pan which monitors all systems and r duces the number of supervisory pe sonnel needed.

New buildings planned

Plans for a Large Animal Clin that will house 120 animals ha been completed. This structure w be attached to the west wing of th Small Animal Clinic. Bids for co struction will be let as soon as fun are released.

Currently a committee is form lating plans for the relocation of th Basic Sciences unit. This task is e pected to require two phases.

An Animal Holding Facility is al programmed for this campus. Th building will have facilities for r

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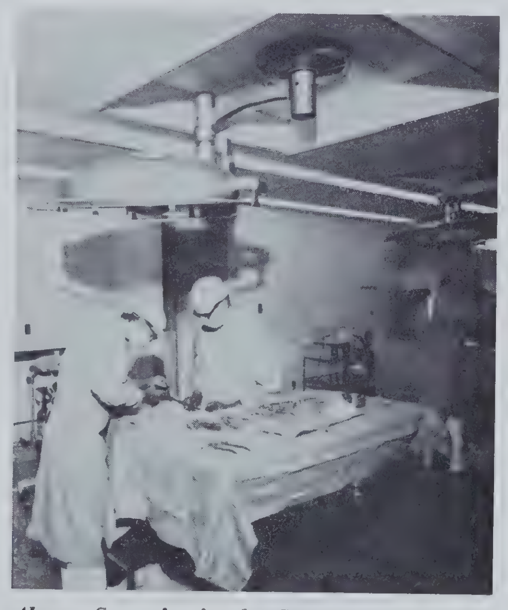
Aerial view of new campus (taken before landscaping was finished). Large Animal Surgery and Obstetrics Building is in foreground, nd behind it is the Small Animal Clinic. Small building in left background is the heating and cooling plant.



Above. **Surgeries in the Small Animal Clinic have piped-in oxygen and good surgical lighting.**

Top left. **A close-up view of the clinic's exterior.**

Bottom left. **A well-equipped clinical pathology laboratory is located on the first floor.**

iving, quarantining, and dispersing laboratory animals coming to the bana-Champaign campus. Such faities, by providing healthy, unin-ted animals for experiments, will lp to insure the validity of research ults.

According to present plans, the proposed buildings will be completed by 1980. At that time, 135 students can be admitted to the College annually as compared with the 78 that are now admitted each year. Even so, the College will still be unable to accept about two-thirds of the qualified applicants.

Completion of the new campus will be a step toward training the veterinarians that are needed to help care for the health and welfare of every living being.

Minimum Aeration for Control of Odors From Swine Wastes

JAMES C. CONVERSE and DONALD L. DAY

DEVELOPMENT of the oxidation ditch has given the swine producer a new tool for treating manure and controlling odors. The oxidation ditch operates on the principle that if enough air is supplied to the liquid manure, the wastes will be stabilized by aerobic bacteria (bacteria that must have a continuous supply of oxygen). Carbon dioxide and water are by-products of aerobic treatment, so the mixed liquor in the ditch is practically odorless.

For optimum degradation, thus unlimited aerobic bacterial action, a minimum dissolved oxygen concentration of 0.5 to 1.0 milligram per liter should be maintained in the mixed liquor. Maintaining this level of oxygen, however, is expensive. It would be advantageous if the costs of operating an oxidation ditch could be reduced for the producer who wanted only odor control.

One way of reducing costs would be to decrease the amount of oxygen added to the manure. A study was therefore conducted to determine whether odors could be kept at an acceptable minimum if a liquid swine manure system was operated so that no residual dissolved oxygen was present. A second objective was to determine how much the manure would be degraded under such conditions.

Five treatments compared

The study was performed in the laboratory over a 22-week test period. The system consisted of five chambers, each holding a constant volume of 15 liters. One liter of mixed liquor was removed daily and 1 liter of diluted hog manure (1 part manure to 4 parts water) was added each day. This gave a 15-day retention period for the diluted manure. Contents of the chambers were mixed continuously so a representative portion of the liquor was removed daily.

Chamber 1 was excessively aerated, causing residual dissolved oxygen (DO) to be noticeably present. Chamber 5 did not receive any air at all so that anaerobic conditions were maintained. Air was added continuously to chambers 2, 3, and 4 at rates to maintain the oxidation reduction potential (ORP) at −200, −300, and −400 millivolts, respectively.

ORP, rather than dissolved oxygen concentration, was used in controlling air flow rates to the chambers because there was no residual oxygen in any of the chambers except chamber 1. A definite relationship exists between ORP and the aerobic-anaerobic condition in liquid manure systems. Aerobic bacteria operate in the higher ORP range (the smaller the negative number of millivolts, the higher the ORP range). Anaerobic bacteria operate in the lower ORP range, represented by the larger negative numbers. Thus, chambers 2, 3, and 4 ranged between the completely aerobic conditions of chamber 1 and the completely anaerobic conditions of chamber 5.

Swine manure (both urine and feces) was collected from a pen with a partially slotted floor. The pen contained 10 hogs with an average weight of 125 pounds. Characteristics of the manure are given in Table 1.

ORP, pH, temperature, and dissolved oxygen levels in the mixed liquors were recorded daily. Solids, chemical oxygen demand (COD), biochemical oxygen demand (BOD), total sulfides, volatile acids, oxygen uptake, and fertilizer value were also measured. Off-gases were analyze for hydrogen sulfide, oxygen transfe carbon dioxide, methane, ammoni volatile organic sulfur compound and amines.

Effects of treatments on odors

Data for the first 7 weeks we not included as the bacteria we becoming acclimated and the system were coming into equilibrium. F most of the analysis, the data we grouped into three periods: wee 8-13, 14-22, and 8-22. Table 2 giv the average ORP and pH for chambers for weeks 8-22. An avera DO of 4.68 milligrams per liter w maintained in chamber 1, while me surable DO was only present fro time to time in chamber 2. No D was found in chambers 3, 4, and

Hydrogen sulfide, a highly odoro gas indicative of anaerobic con tions, was not found in the off-ga of chambers 1 and 2. In chamber the daily concentration of hydrog sulfide was consistently low (chart). In chambers 4 and concentrations were both high a

Table 1. — Average Values for th Characteristics of the Swine Waste

Parameter and unit of measurement	Val
pH	7
Chemical oxygen demand (COD), mg./l.	155,
Biochemical oxygen demand (BOD), mg./l.	59,
Moisture content, pct.	8
Total solids (TS), mg./l.	104,
Total volatile solids (TVS), mg./l.	84,
Total inert solids (TIS), mg./l.	19,
Percent TVS of TS	8
Suspended solids (SS), mg./l.	84,
Suspended volatile solids (SVS), mg./l.	72,
Suspended inert solids (SIS), mg./l.	12,
Percent SVS of SS	8
Percent SS of TS	8
Total nitrogen, pct. dry basis	3
Phosphorus, pct. dry basis	2
Potassium, pct. dry basis	1

James C. Converse was formerly a Research Assistant; Donald L. Day is Professor of Agricultural Engineering. This article is based on Mr. Converse's Ph.D. thesis.

rratic. Table 2 gives the average oncentration of hydrogen sulfide, n parts per million by volume, in he off-gases for weeks 19-22. Total ulfides are also given for weeks 8-22.

Another measure of odor in swine nanure is the concentration of volatile acids in the liquid. Chamber had no volatile acids, while chambers 2 and 3 had low amounts compared to chambers 4 and 5 (Table). Only acetic and propionic acids were detected in chambers 2 and 3, with n-butyric and iso-valeric acids ound on several occasions in chamber 3. Acetic, propionic, n-butyric, so-valeric, and n-valeric acids were resent in chambers 4 and 5.

Ammonia concentrations, in parts er million by volume, were 0.201, .97, 4.03, and 7.51 in chambers 1, 3, and 4, respectively, for weeks 9-22. These concentrations are all ss than the threshold odor level hich the human nose can detect.

No volatile organic sulfur comounds were detected in the off-gas f chamber 3, but some may have een present in the off-gases of chamers 4 and 5. There was some indicaon that an amine was present in e off-gases of chambers 2 and 3 and at several amines were present in e off-gases of chambers 4 and 5. owever, no identifications were ade.

Average volatile solids reduction as measured to determine the stability of the organic matter in the treated manure. The more stable the organic matter, the less the manure pollutes the environment; that is, it is less likely to attract flies, give off odors, or contain disease organisms. All five treatments had about the same level of average volatile solids reduction — satisfactory but not ideal.

Another measure of stability is COD reduction. The higher the COD reduction, the greater the stability. COD reductions were 37.4, 32.4, 27.2, and 17.8 percent for chambers 1, 2, 3, and 4, respectively.

Table 2. — Average ORP, pH, Hydrogen Sulfide, Total Volatile Acids, and Total Sulfide Concentrations, Chambers 1-5

Chamber	ORP (8-22 wk.)	pH (8-22 wk.)	Hydrogen sulfide (20-22 wk.)	Total volatile acids (13-22 wk.)	Total sulfides (8-22 wk.)
	mv[a]		ppm as S (vol.)	mg./l.	mg./l.
1	+143	7.34	0	0	0
2	−213	8.27	0	81	1.46
3	−344	8.12	.36	266	11.48
4	−426	7.70	126.70	3,317	19.03
5	−482	6.83	4,326.00	2,784	33.21

[a] Measured with calomel electrode.

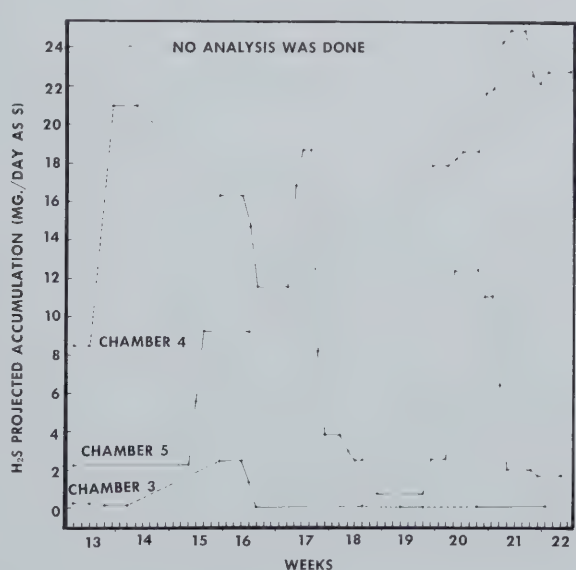
Table 3. — Fertilizer Value[a] of Mixed Liquor in Chambers 1-5 and in Diluted Raw Manure[b]

Chamber	Nitrogen	Phosphorus	Potassium
	mg./l.	mg./l.	mg./l.
1	584	512	274
2	747	515	244
3	685	472	260
4	578	503	272
5	503	497	207
Diluted manure	701	452	291

[a] To convert values to percent wet basis, divide by 10,000.
[b] One part manure diluted with 4 parts water.

Fertilizer value

There was no significant difference in the amounts of phosphorus and potassium in the different chambers (Table 3). However, the average value for nitrogen was significantly higher in chamber 2 than in chambers 1, 4, and 5; and significantly higher in chamber 3 than in chamber 5. In other words, the fertilizer value of the mixed liquor in each chamber was about equal for phosphorus and potassium, but the mixed liquor in chambers 2 and 3 had more organic and ammonia nitrogen than did the other chambers. Chamber 1, but not the other chambers, had some nitrate and nitrite nitrogen, which was not measured.



aily concentrations of hydrogen sulfide in off-gases om chambers 3, 4, and 5 weeks 13-22. The concentration in chamber 3 was nsistently low. Concentrations in the other two chambers were high and erratic.

Chamber 3 conditions were good

The system represented by chamber 3 was judged to have the least amount of aeration that can give reasonably good odor control. Mean air flow rate during weeks 14-22 was 216 cubic feet per pound of 5-day BOD added daily, based on actual oxygen transferred and a 5-percent transfer efficiency. Care should be exercised when using this value, however, because it was ORP that was controlled and not air flow rate. The important thing is to maintain ORP in the range of −300 to −340 and pH in the range of 7.7 to 8.5.

Expected growth of the beef industry in Illinois points up need for evaluating forages

Roundup time at Dixon Springs Agricultural Center.

Forage Evaluation—Development, Use, Value

F. C. HINDS

IN THE FACE of the ever-growing world food crisis, it is imperative that we develop every possible means of increasing our food supplies and utilizing them more efficiently. Much emphasis is being placed on grain production and on recent innovations such as high-lysine corn and double-cropping. However, it seems that far too little attention is being given to two major sources of food — forage crops and crop residues.

The present livestock industry is based largely on feeds that can also be used directly by humans and is thus in direct competition with the human population. As the world population keeps on increasing, we must ask ourselves whether we can allow this competition to continue.

Even if we answer this question in the negative, we can still support large numbers of livestock. From 50 to 60 percent of the land area in the world is suited only to the production of forage crops. In addition, massive quantities of crop residues are not now being completely utilized. At present, domesticated ruminants are our most commonly used means of converting forage crops, as well as crop residues, into nutritious and palatable products for human consumption.

Corn Belt next growth area

In the United States, our domesticated ruminants are mostly cattle and sheep. With the continuing increase in demand for beef and with our growth in population, the beef and sheep industries can be expected to expand in the near future. The traditional cattle- and sheep-producing areas, however, do not have the potential to support many more cow herds and ewe flocks than they do at present. The expansion is therefore expected to occur in the Corn Belt, specifically Illinois, where the capacity to feed more livestock does exist.

Brood cows and ewes can utilize the large quantities of plant residues that are generated by crop production. These residues are expected to be the main source of nutrients for cows and ewes through most of the Corn Belt. Traditional forages will play a minor, though important, role.

The expansion of cow and ewe numbers will probably spill over into the fringes of the Corn Belt. In these areas traditional forages, both grazed and harvested, will be the most important feeds. Crop residues, if used at all, will be of minor importance.

Nutritive value important

Regardless of whether the major source of nutrients for the cow or ewe is a crop residue or a more traditional forage, the feed must meet (or be supplemented to meet) the animal's nutritional requirements. Further, for economic efficiency and maximum productivity, the animal must not be underfed or overfed.

Meeting the specific nutritional needs of the brood female requires rather careful evaluation of a feed's nutritive content. The problem i complicated by the fact that forage from which cows and ewes obta most of their nutritional needs, have much greater range in nutritive valu than do concentrates. Thus, metho for accurately determining fora quality or nutritive value must b used and if suitable methods are n available, they must be develope

Since the early 1800's, agricultur scientists have been hard at the ta of developing laboratory procedur to estimate the nutritive value feedstuffs. Initially chemical pr cedures were developed in an attem to identify undigested and poor digested plant constituents. The constituents were generally referr to as fiber or crude fiber.

Although the fiber component feeds has little nutritional val for nonruminants (hogs, chicken and humans, for example), it is value to ruminants. The rumina digestive system contains billions mircroorganisms capable of digesti fiber. Thus, nutritive value es mates that assume the indigestibil of fiber have much less value f ruminants than for nonruminan

To evaluate forages or roughag for ruminants, some nutritionists recent years have been using an "artificial rumen," or in vitro fermenttion techniques. The fermentati in the artificial rumen closely si ulates the microbial digestive pr cesses in ruminants.

Three essential characteristics

The quality of a forage or nutritive value for a ruminant larg

F. C. Hinds is Associate Professor of Animal Science.

depends on three interrelated characteristics: (1) chemical composition, (2) the degree to which the forage is digested, and (3) the degree to which animals will consume the forage.

Obviously, if a forage does not contain enough essential nutrients to meet an animal's requirements, it doesn't matter how much of the forage is consumed or how digestible it is; the performance of the animal consuming the forage will be limited.

On the other hand, even though analytical procedures suggest that the forage contains more than enough of the required nutrients, this does not necessarily mean that it will satisfy the animal's needs. Unless the nutrients can be made available through digestion and absorption, they are of no value to the animal.

Finally, even if chemical composition and digestibility are adequate, these qualities mean very little if the forage is not acceptable to the animal and intake is low. Unless a forage is consumed at appropriate levels, its composition and digestibility do not indicate its ability to sustain a desirable level of performance. Many researchers consider that intake is the most important of the three factors limiting the performance of animals on forage.

It is apparent that a useful system of forage evaluation must provide information on intake as well as on composition and digestibility. Of course the ultimate test is to feed the forage to livestock and observe the resulting performance. However, although feeding and digestion studies are the ideal methods for evaluating forages, they are expensive, take too long to conduct, and will not work on small forage samples.

Both researchers and producers can use forage evaluation

Many laboratory methods have been studied in an attempt to develop more suitable systems for evaluating forage, including intake as well as composition and digestibility. So far, only limited success has been obtained in predicting intake of forages. However, a few chemical and microbial assays have been found useful in determining composition and digestibility. These methods could be of value to both researchers and producers.

Researchers are using forage evaluation techniques in plant breeding programs to identify outstanding plants and strains for development into improved varieties. Since the laboratory assays used in plant breeding programs require only very small samples, it is sometimes possible to study a single plant and determine whether it has the characteristics important to animal performance. This approach has been successful at several experiment stations. Also, scientists interested in forage management can use laboratory assays to develop systems of management that maximize the acre yield of animal products.

The application of forage evaluation to practical situations has been rather limited. In a few states (though not in Illinois) the extension service or other public agencies have provided both analytical and advisory services. Commercial laboratory services are available in Illinois, as well as in other states. However, far too few cattle and sheep producers have used the analytical services available to them.

The producer using an analytical service can obtain information on the quality of feed available to him and, on the basis of this information, develop nutritionally sound feeding programs for his livestock. If he is particularly observant, he will also learn much about producing higher quality forage.

In the future, producers will probably be using laboratory services much more than in the past. This prediction is partly based on the probability that livestock producing units will increase in size. With increased size will come greater specialization and a greater emphasis on economic efficiency. It will no longer be practical to overfeed or underfeed livestock just because you don't know the nutritive value of the roughage fed.

Overfeeding and underfeeding costly in several ways

Some very shocking examples of both underfeeding and overfeeding can be seen in the Corn Belt. Underfeeding — resulting from poorly balanced rations containing very low-quality roughages — can reduce calving percentages and retard calving dates.

Both results of underfeeding can be costly. For example, if calving percentage is reduced by 10 percentage points, the producer not only loses 10 calves per 100 cows, but also has had to pay the room and board for 10 unproductive cows. If calving is delayed a month, feeder calves will be 40 to 50 pounds lighter at sale time than calves born on schedule. At a price of $30 a hundredweight, the loss would be between $1,200 and $1,500 (the equivalent of 10 calves).

Overfeeding can be as costly. It not only wastes feed, but also reduces the brood female's reproductive rate, shortens her reproductive life, and causes difficulty at calving or lambing. The example can again be a 100-cow herd. If allowed as much silage as they can eat, average-sized cows may consume 50 to 60 pounds of silage a day. If 100 cows consume an average of 55 pounds a day over a 150-day feeding period while needing only 45 pounds, this means a wastage of 75 tons of silage. The overall effect of overfeeding on reproduction can be as dramatic as that of underfeeding.

The foregoing examples, which are not unrealistic, point to the need for sound nutritional programs. To develop these sound programs for the brood cow and ewe, a system of evaluating the nutritive value of forages and roughages is essential. As producers in Illinois and other Corn Belt states enter the era of producing calves and lambs from previously unused roughages, forage evaluation will become as vital for livestock production as the soil test is for crop production. Forage evaluation is thus another of the technological tools used in the fight to feed the world.

FARM BUSINESS TRENDS

THE BUSINESS OF FARMING is strongly influenced by inflation. There are at least two different kinds of inflation, with different causes and effects.

In earlier times inflation was caused by large increases in the supply of money, which increased the demand for farm products and raised their prices.

When gold was the principal money, big new discoveries of the precious metal brought prosperity to farmers (and producers of other raw materials). There were such discoveries in Central and South America in the 16th century, in California and Australia around 1850, and in the Klondike and Yukon in the 1890's.

During World Wars I and II large amounts of paper currency and checkbook money were created and put into circulation. Again the increase in the supply of money increased the demand for farm products. Prices received by farmers went up much faster than prices paid for items used in farm production and family living.

The new-style inflation is a different disease. Its primary cause is excessive increases in salaries and wages. The resulting higher labor costs are injurious to agricultural producers in three ways: (1) They increase the costs of processing and distributing farm products, thus reducing the farmer's share of the consumer's dollar and depressing prices of farm products. (2) Higher wages increase the costs of farm equipment and supplies, which reduces net farm income. (3) Higher labor costs also increase the prices of the products and services that are essential for family living.

Our government has tried to control wages and prices four times since 1940. Such efforts were made during World War II, in the post-war adjustment period, during the Korean War, and during the early 1960's. Each of these programs had some temporary success, but each broke down under pressure. Many other countries in the free world have had similar experiences.

Cost-raising pressures now are greater than ever before during peacetime. A larger proportion of the nation's population is organized to press demands for increases in wages and salaries. These demands are greater than heretofore. It is becoming increasingly difficult to offset wage increases by mechanization and automation. A larger proportion of our working force is employed in providing services (rather than commodities), which are not easily mechanized.

Judging from the past experiences and recent trends outlined above, inflation will continue as a major problem for farmers for several years, at least.

Looking ahead further into the future, there seem to be three alternatives concerning wages and salaries: (1) They may be allowed to continue uncontrolled, in which case the rate of inflation seems likely to increase. (2) They can be brought under public control, as are charges for electric power and telephone service. (3) Controls may be imposed by a dictatorial government. Which will we choose? — *L. H. Simerl, Professor of Agricultural Economics.*

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Spring, 1972

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Illini Spinwheel, a small and dainty new chrysanthemum recently developed at the University, fits well into almost any spot in the home (page 14).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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AGRONOMY DEPARTMENT HAS NEW HEAD

On November, 1, 1971, Robert W. Howell became the sixth hea of the Department of Agronomy. He was already well know in Urbana-Champaign, having been on the campus from 1952 t 1964 as a plant physiologist with the U.S. Regional Soybean R search Laboratory. At the same time he was also a member of th Agronomy staff and of the graduate faculty of the University.

While at the Soybean Research Laboratory, he was especial interested in lipid synthesis in the soybean plant and phosphor sensitivity in soybeans. He also studied the effect of temperature c the percentage of oil in the fatty acid composition of the soybea

When he left Urbana-Champaign in 1964, it was to go to th Agricultural Research Service (ARS), Crops Research Divisio Beltsville, Maryland. After two years as leader of soybean invest gations there, he became head of the oilseed and industrial cro research branch.

In addition to his regular work, he has accepted a number special assignments, including the following: co-chairman of th Joint Task Force on Peanut Research: member of the adviso board of the National Soybean Crop Improvement Council; mer ber of the USDA's Food Safety Work Group on Chemicals ar Toxins; member of the Rockefeller Foundation's team to surv soybean potential for inclusion in the Center for Tropical Agricu ture, Palmira, Colombia. He was editor of *Crop Science* from 196 to 1970, and has been editor-in-chief of the Crop Science Socie of America since 1971. He was named a Fellow of the Americ Society of Agronomy in 1969.

Established in 1899, Agronomy is the oldest department of th University of Illinois College of Agriculture. Previous heads ha been Perry G. Holden (1899-1900), Cyril G. Hopkins (190 1919), William L. Burlison (1919-1951), Morell B. Russell (195 1963), and Marlowe D. Thorne (1963-1970).

Although Dr. Thorne resigned the headship in 1970, he remai on the University staff as professor of agronomy. He is now chi of the University of Illinois party at Uttar Pradesh Agricultur University, India. Fred W. Slife served as acting head of the Agro omy Department between Dr. Thorne's resignation and D Howell's assumption of his duties. — *G. W. Salisbury*

Gypsum Improves Corn Yields on Natric Soils by Removing Sodium

J. B. FEHRENBACHER, H. J. KLEISS, A. K. SHARMA, and B. A. JONES, JR.

ORN YIELDS on a natric or high- sodium soil can be increased by re than 50 percent if gypsum is ced generously with the top 3 feet soil. This has been found in a dy on Huey silt loam at the New- . Agronomy Field during the past ears.

\ high exchangeable sodium con- t causes a poor physical condition the B horizon or subsoil of natric s. As a result, rooting is restricted, ter and nutrient uptake is limited, l crop yields are low. These soils extensive in south-central and thwestern Illinois, commonly oc- ring as irregularly sized and ped areas associated with non- ium "claypan" soils.

Natric soils were described in the nter, 1966, issue of ILLINOIS RE- RCH, and early yields were sum- rized in the Summer, 1967, issue.

atment of plots

ll plots in the Newton study re- e 160 pounds of nitrogen per acre h year and enough phosphorus l potassium to maintain high levels hese nutrients. But the main soil endment being studied is gypsum lcium sulfate), which furnishes cium to replace the sodium held the cation exchange sites on the particles. The effects of gypsum both corn yield and sodium re- val are being determined.

The gypsum was applied in August, 3. Different rates, depths, and hods of application were com- ed with various tile spacings on licate plots (Tables 1 and 2). The -ton rate was calculated to re- e the sodium in the top 2 feet of ; the 27.8-ton rate, in the top 3 .

On surface-treated plots, gypsum at the 10.7-ton rate was plowed into the surface 6 inches (some plots were plowed without gypsum). On chiseled plots, the same amount of gypsum was chiseled 2 feet deep in chisel tracks 2 feet apart in both a north-south and an east-west direction.

Gypsum was applied at the 27.8-ton rate on the treated mixed plots, and was thoroughly mixed with the top 3 feet of soil by a backhoe. Some plots had the top 3 feet of soil mixed without gypsum.

Tile were installed to remove the sodium that is replaced by the calcium in the gypsum. In the surface and chiseled plots, tile spacing was 30 feet (some surface plots were not tiled). In the mixed plots, spacings were 10, 30, and 60 feet.

Effect of gypsum on corn yields

Corn yields from 1964 to 1971 were quite variable depending both on the treatments and on the weather. In general, yields were lowest in 1966 and were highest in 1967, when weather conditions were unusually favorable (Tables 1 and 2).

By far the best yields were obtained with the high rate of gypsum mixed 3 feet deep. The difference between this treatment and the conventional treatment without gypsum was highly significant.

The next best yields resulted from chiseling the gypsum 2 feet deep. However, these yields were only slightly better than those from the surface treatments and were significantly lower than yields from mixing the gypsum 3 feet deep (Table 1, line 6 vs. line 4).

Adding gypsum to the surface 6 inches gave no better yields than conventional treatment without gypsum. Too little of the gypsum moved from the surface into the high-sodium, very slowly permeable subsoil.

In general the plots mixed to 3 feet without gypsum had the lowest

Table 1. — Corn Yields From Various Treatments at Newton, 1964-71

Line	Gypsum per acre	Depth of soil disturbance	Tile spacing	Corn yields per acre								
				1964	1965	1966	1967	1968	1969	1970	1971	Aver.
	tons	*feet*	*feet*	*bushels*								
1....	None	Surface ½	30	47.9	41.5	33.6	123.7	80.6	70.9	58.8	68.4	65.7
2....	10.7	Surface ½	None	45.4	42.4	26.1	146.8	81.4	89.5	47.4	65.8	68.1
3....	10.7	Surface ½	30	63.4	39.8	35.4	129.0	76.6	72.6	60.2	62.8	67.4
4....	10.7	Chiseled 2	30	70.0	62.2	38.0	123.4	80.0	83.3	62.8	76.6	74.5
5....	None	Mixed 3	30	67.8	50.2	48.6	88.2	45.0	58.5	59.8	66.6	60.6
6....	27.8	Mixed 3	30	93.2	113.7	96.4	140.9	89.0	124.4	86.7	105.2	106.2
Aver.	...	...	...	64.6	58.3	46.4	125.3	75.4	83.2	62.6	74.2	73.8

Comparisons of treatments

Item A		Item B	Aver. yields per acre		
			Item A	Item B	Diff.
			bushels		
Tile 30 ft. (line 3)	vs.	No tile (line 2)	67.4	68.1	−0.7
Gyp. surface ½ ft. (line 3)	vs.	No gyp. (line 1)	67.4	65.7	1.7
Gyp. chiseled 2 ft. (line 4)	vs.	No gyp. (line 1)	74.5	65.7	8.8
Gyp. chiseled 2 ft. (line 4)	vs.	Gyp. surface ½ ft. (line 3)	74.5	67.4	7.1
Gyp. mixed 3 ft. (line 6)	vs.	Gyp. chiseled 2 ft. (line 4)	106.2	74.5	31.7*
Gyp. mixed 3 ft. (line 6)	vs.	No gyp. (line 1)	106.2	65.7	40.5**

* Difference significant at 5-percent level. ** Difference significant at 1-percent level.

Fehrenbacher is Professor of Pedology; . Kleiss and A. K. Sharma are Research tants, Agronomy; and B. A. Jones, Jr., is ssor of Agricultural Engineering.

yields (Table 2). The difference between these yields and the yields on the plots mixed with gypsum was highly significant (Table 2, line 14 vs. line 10). Mixing the high-sodium subsoil with the surface soil without adding gypsum produced a very poor physical condition in the plow layer, stunting corn growth.

Increasing tile spacing from 10 to 30 feet did not significantly reduce yields on the mixed plots either with or without gypsum. However, on the mixed plots with gypsum, yields with the 60-foot tile spacing were significantly lower than with 10-foot spacing, and almost significantly lower (at the 5-percent level) than with 30-foot spacing (Table 2). This indicates that tile should be no more than about 30 feet apart for best results from the mixed high-gypsum treatment. Tiling did not increase yields on any of the surface-treated plots (Table 1).

Sodium removal

Total flow and sodium content of the tile drainage water have been hard to measure because of sediment filling the tile lines. The tile had to be taken up and cleaned in both 196 and 1966. After the first cleanin graded gravel filters were installe and in 1966 these were replaced wi filters of straw plus pea gravel. Al in 1966, the tops of tile joints we covered with plastic in an effort stop silting.

After the straw and pea grav filters were installed, the tile fun tioned best and most consistent during the 27½ months from May 1 1967, to August 30, 1969. The ti flow and amounts of gypsum remov during this period were used to ca culate annual rates of removal und the various conditions of the stud Using these rates, we estimated t length of time necessary to remo the sodium (16,390 pounds per acr from the top 3 feet of soil (Table 3

Although the measured tile fl and sodium removal are not hig accurate, we can draw some concl sions from the data in Table 3: T best way to flush sodium from Hu silt loam is to mix gypsum in t top 3 feet. The least effective tre ment is to mix the top 3 feet of s without gypsum. In general, these sults are consistent with the co yields discussed above.

New subplots

In October, 1971, six modificati were made in duplicate on 12-by- foot subplots (Table 4). The n treatments will, it is hoped, prov more information about natric so

Table 2. — Corn Yields on Mixed Plots at Newton, 1964-1971

Line	Gypsum per acre	Depth of soil disturbance	Tile spacing	Corn yields per acre								
				1964	1965	1966	1967	1968	1969	1970	1971	Aver.
	tons	*feet*	*feet*	*bushels*								
7	None	Mixed 3	10	52.5	46.2	36.6	92.6	43.2	56.1	52.8	73.8	56.7
8	None	Mixed 3	30	67.8	50.2	48.6	88.2	45.0	58.5	59.8	66.6	60.6
9	None	Mixed 3	60	55.8	33.4	39.4	79.2	40.4	38.6	48.0	57.2	49.0
10 (Aver., lines 7-9)			..	58.7	43.3	41.5	86.6	42.8	51.0	53.5	65.8	55.4
11	27.8	Mixed 3	10	89.8	100.6	99.2	164.2	105.9	124.2	92.0	104.4	110.0
12	27.8	Mixed 3	30	93.2	113.7	96.4	140.9	89.0	124.4	86.7	105.2	106.2
13	27.8	Mixed 3	60	73.7	77.0	88.1	127.0	64.5	86.8	81.0	86.8	85.6
14 (Aver., lines 11-13)			..	85.6	97.1	94.6	144.0	86.4	111.8	86.6	98.8	100.6

Comparisons of treatments

Item A		Item B	Aver. yields per acre		
			Item A	Item B	Diff.
			bushels		
Mixed 3 ft. with gyp. (line 14)	vs.	Mixed 3 ft. without gyp. (line 10)	100.6	55.4	45.2**
Tile 10 ft. (lines 7 and 11)	vs.	Tile 60 ft. (lines 9 and 13)	83.4	67.3	16.1
Tile 30 ft. (lines 8 and 12)	vs.	Tile 60 ft. (lines 9 and 13)	83.4	67.3	16.1
Tile 10 ft. with gyp. (line 11)	vs.	Tile 60 ft. with gyp. (line 13)	110.0	85.6	24.4*
Tile 30 ft. with gyp. (line 12)	vs.	Tile 60 ft. with gyp. (line 13)	106.2	85.6	20.6

* Difference significant at 5 percent level. ** Difference significant at 1 percent level.

Table 3. — Annual Tile Flow and Sodium Removal at Newton, Based on Period from May 14, 1967, to August 30, 1969

Gypsum per acre	Depth of soil disturbance	Tile spacing	Aver. depth of water removed per 12 months	Aver. tile flow per 12 months	Aver. sodium removed per 12 months	Time needed to remove sodium in soil to 3 ft.
tons	*feet*	*feet*	*inches*	*cu. ft./A.*	*lb./A.*	*years*
None	Surface ½	30	2.73	9,922	264	62
10.7	Surface ½	30	2.73	9,922	251	65
10.7	Chiseled 2	30	2.47	8,954	174	94
None	Mixed 3	10	3.10	11,253	162	101
None	Mixed 3	30	2.93	10,648	124	132
None	Mixed 3	60	0.70	2,541	162	101
Aver. no. gyp.	Mixed 3	..	2.24	8,147	149	111
27.8	Mixed 3	10	13.60	49,368	1,135	14
27.8	Mixed 3	30	8.70	31,581	930	18
27.8	Mixed 3	60	2.07	7,502	387	42
Aver. 27.8 gyp.	Mixed 3	..	8.12	29,484	818	25

Table 4. — New Treatments on Subplots

Original treatment, August, 1963	New treatment, October, 1971
10.7 T./A. gypsum in surface, tiled	20 T./A. gypsum, 12 in. depth
10.7 T./A. gypsum, chiseled 2 ft., tiled	Same as above
No gypsum, mixed 3 ft., tiled	20 T./A. gypsum, 0 in. depth
No gypsum, tiled	20 T./A. hydrated lime, 12-24 in. dep
10.7 T./A. gypsum in surface, no tile	Same as above
No gypsum, mixed 3 ft., tiled	20 T./A. hydrated lime, 0-12 in. depth

An Automatic Concentrate Feeder for Dairy Cows

. E. HARSHBARGER, G. M. HYDE, E. F. OLVER, H. B. PUCKETT, and R. A. FROBISH

A cow enters electronic feeder building while another waits her turn. (Fig. 1)

)URING the past two decades, the dairyman has increased output f milk per worker and has earned better return for his labor and in-estment. All this has been largely ue to the mechanization of milking nd other chores.

Further automation may be nec-ssary for the dairy industry to keep ace with alternative enterprises. 'ne possibility is to mechanize the eding of grain or concentrates.

High-producing cows need concen-ates for extra energy beyond that hich is supplied by forage. Although rage can be fed free choice, the nount of concentrates must be con-olled to obtain the most economic vel of intake. They are therefore ually fed in the milking parlor. his often requires extra time and eaning, and spilled concentrates n increase the fly problem.

An experimental electronic con-ntrates feeder has been developed the University of Illinois. It dis-nses concentrates at any hour of e day or night, with a minimum of pervision. The amount each cow ceives is controlled according to r milk production.

The cows can be housed as a group d fed forage free choice. To re-ive concentrates, a cow must enter special feed stall in the feedlot 'ig. 1). The stall is equipped with concentrate dispenser, a feed bowl, electronic interrogator, and an tenna for the interrogator.

Each cow carries an electronic vice called a transponder on a col-around her neck (Fig. 2). The insponder contains an analog mem-y element such as a capacitor, and signal generator. The transponder tenna is in the collar.

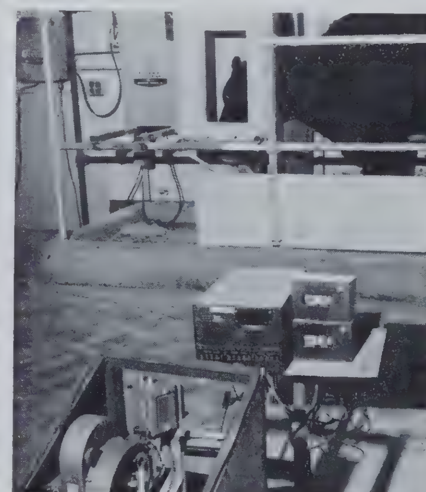
As the cow enters the stall, her ad goes through the loop of the errogator antenna, which transmits radio frequency power to the neck transponder antenna. This power charges the memory element in the transponder. The signal generator in the transponder runs also, transmitting a signal to the interrogator and causing the concentrate dispenser to run. When the memory reaches full charge, meaning the cow has received her quota of concentrates, the signal generator stops. The interrogator then stops the dispenser.

The neck transponder unit emits a frequency which turns on the feeder and regulates the amount of feed according to the cow's production. (Fig. 2)

The time required to recharge the memory is adjustable to control the total time a cow can obtain feed in a day. This in turn determines the amount of concentrates she receives, since the feed is dispensed at only one rate — about a pound a minute.

Feeding trials show that cows fed with this feeder produce at least as well as hand-fed cows. The unit gives excellent control of the amount consumed. This system is now being compared with a group-feeding system.

A unique monitoring device has been developed for the experiment (Fig. 3). A movie camera in the feeding building exposes one frame when a cow enters the stall, and another frame when she leaves. The left side of the cow is shown in each picture, along with a calendar clock, concentrate dispenser clock, and a continuous running clock (Fig. 4). The pictures thus show whether all cows are eating and how much each is eating.



Camera in foreground automatically photographs instruments and cow when she enters and when she leaves the feeder stall. The cow is eating from the feeder; the feed dispenser is in front of her head; controls are on the far left. (Fig. 3)

This camera system not only collects research data but is also an excellent way to study animal activity patterns and to determine the maximum number of cows that can be fed.

Two frames from data-record film showing a cow entering and leaving feeder. Clocks in foreground show date, time, and amount of feed dispensed. (Fig. 4)

K. E. Harshbarger is Professor of Nutrition, Dairy Science Department; G. M. Hyde and H. B. Puckett are with the USDA; E. F. Olver is Professor of Agricultural Engineering; R. A. Frobish is Research Assistant.

Geotrichum Sour Rot of Peach

An unusual organism that can infect humans as well as plants, Geotrichum has been found on cankered twigs in Illinois peach orchards

D. M. FILIPEK, C. GAIROLA, and D. POWELL

An interesting member of the plant kingdom is a yeastlike fungus with the scientific name of *Geotrichum candidum* Lk. ex Pers. emend. Carmichael. It is one of the few organisms that can infect both humans and plants.

In humans, some strains of this fungus cause a disease called geotrichosis, which is defined medically as an infection of the bronchi or lungs and sometimes of the mouth or intestinal tract.

In plants, *G. candidum* causes a soft, sour rot which emits a vinegary odor. The fungus usually enters a fruit through a bruise or wound. It has been reported on citrus fruits, tomatoes, peaches, muskmelons, and other fruits. Cucumbers, peppers, carrots, and pine roots have also been infected. The incidence of *Geotrichum* fruit rot is on a gradual increase around the world.

Many strains of *G. candidum* are not pathogenic and inhabit soil, silage, sewage, dairy products, sauerkraut, and the human body.

When grown in culture, *G. candidum* produces a well-developed white mycelium with dichotomously branched hyphae (filamentlike growths). The hyphae segment into chains of cuboidal or short cylindrical arthrospores with flattened ends.

This fungus was found in Illinois peach orchards during a survey in the spring and autumn of 1966 and 1967. Purpose of the survey was to determine the prevalence of perennial peach canker caused by the fungus *Cytospora* sp. Cankered twigs were collected from different orchards and fungi were isolated from the twigs. The *Geotrichum* fungus was one of the organisms frequently isolated.

Because of the prevalence of *G. candidum* in Illinois peach orchards, as well as its growing importance in the world, its pathogenicity on peach twigs and fruits was studied in the Department of Plant Pathology.

Twig infections

Preliminary studies were carried out to determine whether the *G. candidum* that we isolated from perennial cankers was a pathogen on peach twigs. Inoculations were made on 1- to 2-year-old twigs from Red Haven peach trees.

The twigs were surface-sterilized; potato dextrose agar (PDA) plugs carrying actively growing fungus were placed under bark flaps; and the wounds were taped. Additional twigs were similarly inoculated with seven other fungi isolated from perennial cankers. Control twigs were inoculated with PDA without any fungus. All twigs were stored at 25° C.

Within 12 days, lesions developed in the twigs inoculated with *G. candidum*. The lesions took the form of depressed and discolored areas around the infection sites (Fig. 1). At the 25° C. storage temperature, the day-to-day progression of lesion development was variable. No lesions

Peach twig infected by *Geotrichum can-didum* shows a slightly depressed, di-colored lesion. (Fig. 1

appeared in twigs inoculated wit other fungi or in the control twig

This is the first reported stu showing that *G. candidum* causes le sions on peach twigs. The resul demonstrate that this particula strain can infect woody tissue.

Cross inoculations showed that th isolate was also capable of inciting sour rot in lemon, lime, orange, ar tomato fruits.

The occurrence and survival G. *candidum* on peach twigs appea

D. M. Filipek is a Research Assistant; C. Gairola, a former Research Assistant; and D. Powell, Professor of Plant Pathology.

:o be significant in view of the occur-ence of peach sour rot in some narkets. The role of this fungus in issociation with the perennial peach :anker disease is not clear since it was ound most frequently in the older :ankers. However, the perennial can-:er could be an important source of *;. candidum* inoculum.

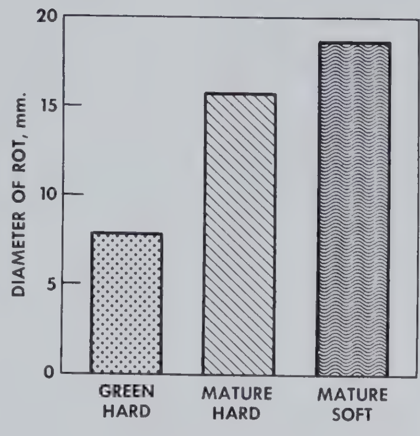
In view of the pathogenic capabil-ty of this fungus, further research hould establish whether or not it is . significant, weak, secondary faculta-ive parasite in the perennial peach anker complex.

ruit infection varies with legree of maturity

The peach twig isolate of *G. can-'idum* which we obtained during 966 and 1967 and which had caused ot in citrus fruits and tomatoes in he laboratory, lost its virulence in torage on PDA at 4° C. We later ob-ained a peach fruit isolate (GEO 67, JSDA Market Pathology Investiga-on Laboratory, Chicago) which roved to be pathogenic. This was sed in laboratory studies of fruit ıfection.

Peaches of the Kale Haven variety ere collected at three stages of naturity: green hard (immature), nature hard (still immature but nowing both external and internal nanges in coloration), and mature ft. The fruit was washed gently in solution of 0.2-percent sodium ypochlorite for 5 minutes, rinsed in erile distilled water, and air-dried. Each fruit was punctured with a erile, 17-gauge needle, creating a nall wound to a depth of about 1.5 illimeters below the exocarp (skin). en microliters of a standardized spension of arthrospores of *G. can-dum* were injected on the wound, nd the fruits were stored at 25° C. a ventilated moist chamber. Con-ol fruits were injected with a erile buffer solution. Results were corded as the mean diameter of the t below the exocarp (Fig. 2).

Conspicuous rot symptoms were served on mature hard and ma-re soft peaches 28 to 36 hours after oculation. A dark brown, sour-elling rot of mushy consistency spread laterally and downward from the inoculation site, sometimes forming cavities in the mesocarp (flesh) of the fruit. Masses of white arthrospores were often detected in the rotted areas. The rot frequently extended to the pit and sometimes involved the tissue surrounding it. Rotted tissue just under the exocarp usually collapsed, creating a concave depression. Mature soft fruit was more susceptible than the mature hard fruit, but considerable rotting occurred at both stages.



The influence of peach fruit maturity on sour rot development. (Fig. 2)

In both the mature soft and mature hard fruits, severity of the wound appeared to influence the extent of the rotting. The *G. candidum* organism was readily isolated from the rotted peach tissue.

The green hard fruits manifested only a limited amount of rotting in the area of the wound. Control fruits were free of rot.

The high susceptibility of the mature and ripened fruit to a sour rot caused by *G. candidum* is consistent with the results obtained by other workers.

Effects of temperature

To study the effect of temperature on sour rot development in mature soft peaches, fruits were punctured and inoculated as before. They were then stored at 7°, 10°, 15°, 20°, and 25° C. No rot occurred at 7° C. (Fig. 3). Only a slight amount of rot developed at 15° C., and it was mostly localized in the wound area. Rot was extensive at 20° C. (68° F.) and severe at 25° C. (77° F.) in 72 hours of incubation. When peaches that had incubated for 72 hours at 7° C. were transferred to 25° C., rot developed within 3 days.

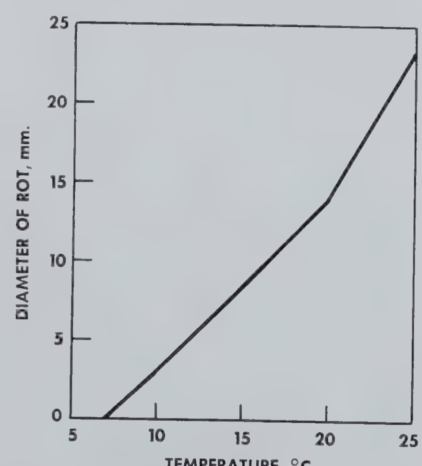
Severe rotting also occurred at 30° C. (86° F.), but the fruit tissue deteriorated so rapidly that it was impossible to measure the extent of the rotting. Warm temperatures clearly favored the rapid development of rot.

A potential danger

It is certain that injured or bruised mature peaches held at warm, ripening temperatures are predisposed to *G. candidum* sour rot. If the organism should become lodged on the fruit before harvest, then it could infect the fruit during post-harvest handling and marketing. It has previously been shown that strains of this fungus which are pathogenic to humans can also infect fruit and cause rot.

Some research workers have speculated that the increase of *Geotrichum* sour rot may be due to the control of other fruit rot diseases by fungicides. These diseases could have been masking *Geotrichum* sour rot.

Improved care and sanitation during handling, and removal of prematurely ripened fruit will aid in the reduction of this disease.



Effect of temperature on sour rot development in peach fruit. The *Geotrichum* organism thrives at temperatures of 20° C. (68° F.) or more. (Fig. 3)

TOMATO HARVEST IS HASTENED
Through Use of Chemical Ethephon

WALTER E. SPLITTSTOESSER and JOSEPH S. VANDEMARK

THE BULK of a tomato crop can be harvested 10 days earlier than usual through use of the chemical 2-chloroethyl phosphonic acid — more commonly known as ethephon.

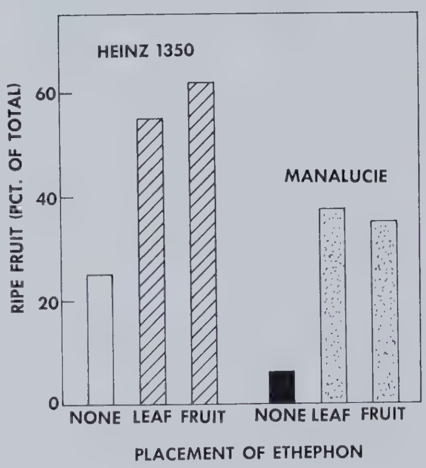
Ethephon readily breaks down to yield ethylene. Recent studies in many states have demonstrated that ethephon, as well as ethylene, accelerates the ripening of tomatoes.

Ethephon was studied by the University of Illinois at the Illinois River Valley Sand Farm in 1969 and 1970. The specific purpose of the study was to determine the effects of various ethephon concentrations on the ripening of fruit from different tomato varieties.

Experiments were conducted on sandy soil in a randomized block design of four replicates with 5 feet between rows. Four cultivars — Manalucie, Heinz 1350, Heinz 1439, and Roma — were grown. Some plots were seeded directly and plants were thinned to 20 plants in 8 feet of row. Six-week-old transplants were planted on other plots at the rate of 10 plants in 15 feet of row.

In some experiments, ethephon and a wetting agent (0.1-percent Tween 20) were applied to either the fruit only or the leaves only when the fruit was at the breaker stage of ripeness. In all other experiments, the entire plants were sprayed when 10 percent of the fruit was pink. Varied concentrations of ethephon were applied at the rate of 40 gallons of solution per acre.

All fruit showing 50 percent or more color were harvested before treatment (first harvest). The sec-

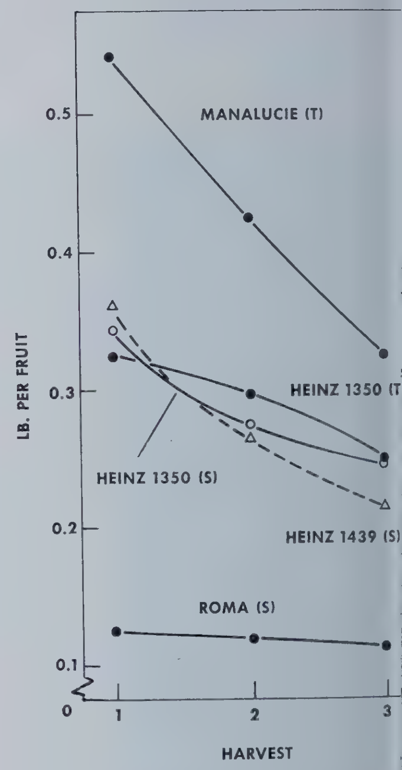


Increase in percent of ripe fruit after applying 5,000 ppm of ethephon to tomato leaves or fruit. (Fig. 1)

ond harvest of such fruit was made 10 days after spraying and the third harvest, 20 days after spraying. Fruit weight and number were recorded for each harvest.

Leaf applications and fruit applications of ethephon were equally effective in promoting ripening (Fig. 1). This suggests that substances controlling fruit ripening are transported from the leaves along with the photosynthate. As has been hypothesized by Iwahori and Lyons, ethephon may trigger a maturation mechanism which affects the ripening process.

Time of harvest influenced the weight of the individual fruits on untreated cultivars, both direct-seeded and transplanted. However, the effect on Roma, the smallest fruited of the varieties grown, was so slight as to be practically nonexistent (Fig. 2). Among the Heinz cultivars, the effect was greater, but the difference still was not significant. The greatest, and only significant, difference in



Effect of time of harvest upon avera weight of harvestable fruit. "T" indica that a cultivar was transplanted; " that it was direct-seeded. (Fig.

fruit size due to time of harv was found in Manalucie, the larg fruited and latest maturing of t cultivars grown.

Manalucie was also the only c tivar in which harvestable fruit s was significantly reduced by eth phon (Fig. 3). By the time of t second harvest, 10 days after app cation, Manalucie fruits that h been treated with only 400 ppm ethephon were appreciably smal than untreated fruits. Higher conc trations reduced Manalucie wei still further. Ethephon caused ma

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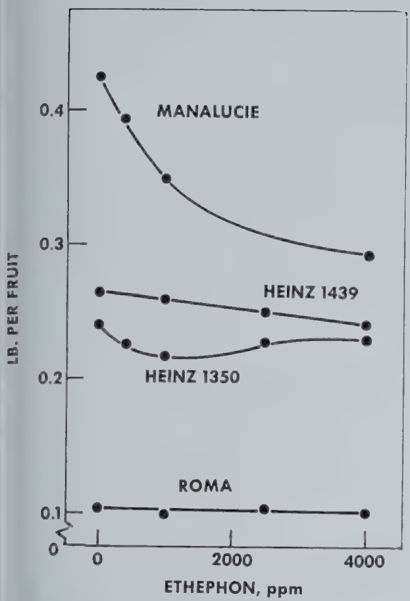
Walter E. Splittstoesser is Associate Professor of Plant Physiology in Horticulture; Joseph S. Vandemark is Professor of Horticulture.



ıverage weight of harvestable fruit 10 ays after ethephon treatments. (Fig. 3)

nall fruits to ripen before they had eached the usual large size for this ariety, thus reducing the average ze at harvest.

Concentrations as high as 4,000 pm of ethephon did not signifiantly reduce the weight of harvestble fruits from any of the other ıltivars.

Ethephon had no significant effect n the total pounds of fruit of directeeded cultivars, but it did influence ıe yield at specific harvest times Fig. 4). In all cultivars, the most pounds of fruit were obtained at the second harvest when plants were treated, and at the third harvest when plants were untreated. This was also true of the transplants (see above table).

Fruit Yield From Transplanted and Direct-Seeded Tomato Cultivars Treated With Water and Ethephon

Cultivar	Planting regime[a]	Ethephon, ppm	Pct. of total yield			Total yield (tons/A.)
			Harvest 1	Harvest 2	Harvest 3	
Manalucie	T	0	8.0	39.0	53.0	7.3
Manalucie	T	1,000	6.1	55.8	38.1	10.2
Heinz 1350	T	0	21.6	28.2	50.2	12.9
Heinz 1350	T	1,000	19.2	56.6	24.2	12.8
Heinz 1439	S	0	21.7	36.9	41.4	23.6
Heinz 1439	S	1,000	23.7	60.4	15.9	22.9
Heinz 1350	S	0	30.1	28.8	41.1	30.3
Heinz 1350	S	1,000	33.0	55.9	11.1	26.1
Roma	S	0	17.5	25.7	55.8	30.4
Roma	S	1,000	15.5	65.0	19.5	31.1

[a] Plants were direct-seeded (S) at 20,000 plants/A. or transplanted (T) when 6 weeks old at 5,000 plants/A.

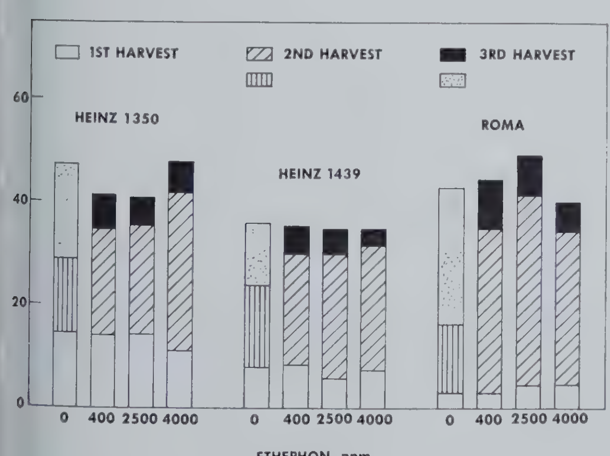
The ethephon-induced increase in total fruit weight at the second harvest was due to a significant increase in the number of ripe fruit (Fig. 5). The number of ripe Roma fruit at this harvest was more than doubled by ethephon. The lowest rate (400 ppm) of ethephon was as effective as the highest rate (4,000 ppm) in increasing both the pounds and the numbers of ripe fruit in the second harvest (Figs. 4 and 5).

As shown in the table, ethephon induced a significant increase in the total yield of harvestable fruit from Manalucie, but not from the other cultivars. Direct-seeded plants yielded more than transplants. This is related to the plant population.

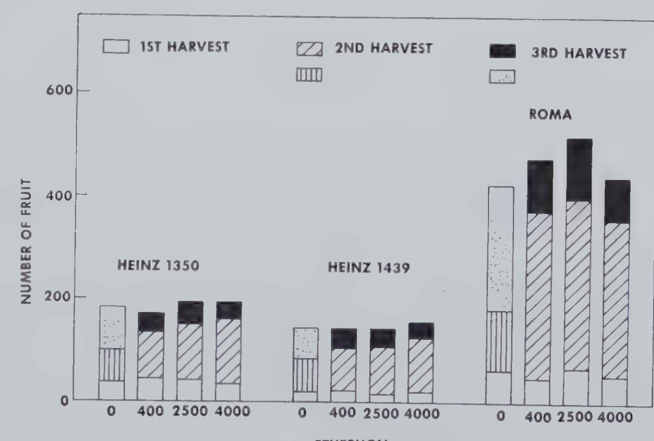
At all rates, ethephon induced chlorophyll degradation in the leaves and stems. Some defoliation resulted from rates of 2,500 ppm or more. A small but significant number of ripe fruit dropped off the direct-seeded cultivars before the second harvest.

Treated fruits are similar in quality to untreated fruits. Ethephon does not change the pH and has little effect on titratable acid or soluble solids.

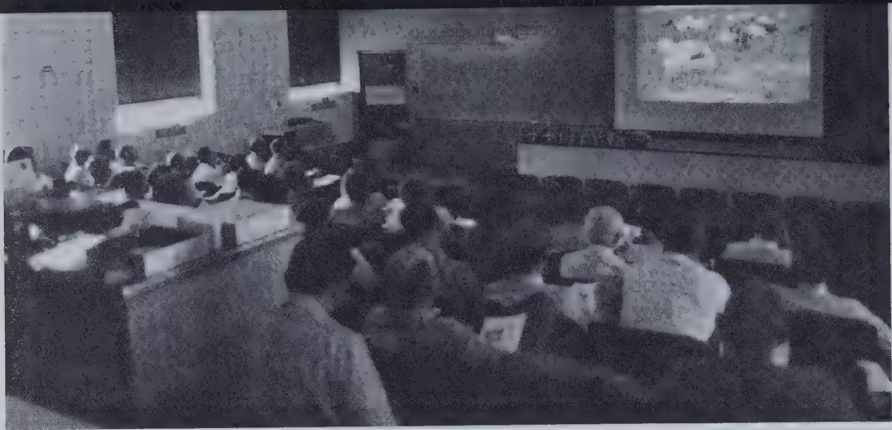
In view of the results obtained both here and elsewhere, ethephon may prove very useful to the commercial producer who wants to accelerate and concentrate ripening.



ƒect of ethephon upon total weight of ripe fruit from three ırvests of several direct-seeded tomato cultivars. (Fig. 4)



Effect of ethephon upon number of ripe fruit from three harvests of several direct-seeded tomato cultivars. (Fig. 5)



Audience watches slides while listening to the TeleNet presentation.

A Farm Tour via TeleNet

E. W. VERNON and D. F. WILKEN

FARMERS often ask, "Can we see how successful hog farmers manage their business?" "Can we talk to farmers who raise hogs in confinement?"

From the early 1920's until the late 1960's, questions such as these resulted in annual farm management tours of outstanding farms. During the 1950's and early 1960's, 2,000 to 4,000 Illinois farmers attended local, area, and state tours every year.

For the first time, in 1969, a farmer turned down a request to host a tour on his hog farm. He believed that the risk of spreading disease was too great. At the same time, local tours were declining both in numbers and in attendance as livestock farms became fewer, more specialized, and spaced farther apart.

However, many farmers still wanted to see how top operators perform. Since it was no longer practical for the public to visit the farm, the best alternative seemed to be to bring the farm to the public.

This was possible with TeleNet, the dedicated line telephone network of the Illinois Cooperative Extension Service. The network transmits an amplified voice signal to meeting rooms in various parts of the state. Audience responses are transmitted with push-to-talk handsets similar to telephone receivers. Slides and other visual aids at the TeleNet outlets supplement the oral presentations.

E. W. Vernon is Assistant Professor of Agricultural Communications; D. F. Wilken, Associate Professor of Farm Management Extension.

The first farm management tour via TeleNet was held on September 2, 1971. It featured two top-managed hog farms — the Gehlbach Pork Farm at Casey and the K. N. Comer and Son Farm at Lincoln. The operators of these two farms participated extensively in planning the tour and in making the TeleNet presentation.

A committee of state extension specialists was in charge of planning the tour. Members included the authors, R. P. Kesler of Farm Management, G. R. Carlisle of Animal Science, and A. J. Muehling of Agricultural Engineering. A field staff of county and area extension advisers and Farm Business Farm Management Association fieldmen coordinated the planning for attendance at the 21 participating outlets.

The state committee prepared the visual package that was sent to each outlet before the tour. The package included slides to be used with the oral presentation, publicity leaflets, and suggested news releases.

On the morning of September 2, about 1,000 farmers gathered at the 21 TeleNet stations. A slide tour of the two farms was narrated from Urbana by members of the state staff and the host farmers. During the noon hour, coordination teams at the TeleNet stations relayed the audience's questions to the specialist team. These questions were collated and categorized into a logical sequence. In the afternoon the specialists and host farmers answered the questions. Answers were supported by slides that

had been prepared in anticipation c
the questions that were likely to b
asked, and had been included in th
visual package.

After the tour was over, it wa
evaluated by the Office of Agricu
tural Communications. To do thi
two attitude scales, based on th
Likert model, were developed. On
scale was for the field staff; the othe
for the audience. Both scales wer
designed to determine attitud
toward the planning, publicity, u
of TeleNet, use of slides, voice qua
ity, opportunity to participate, an
other aspects of the presentation.

The scale for the field staff in
cluded 25 items. The first 22 we
statements designed for a scaled r
sponse with choices ranging fro
"Strongly agree" to "Strongly di
agree." The responses of the 73 fie
staff members who returned the sca
were weighted in the fashion deve
oped by Likert.

The attitude scale used with th
staff is shown on page 11. Also show
are the summated scores of respons
to the first 22 items, together with th
rankings of the scores. The great
the score for a statement, the strong
the agreement with that statement.

Seven items — numbers 1, 4, 6,
10, 13, and 18 — were designed
measure the staff's attitude towa
the total presentation. In general, r
sponses to these items indicated
positive reaction to the tour.

Five of the items — numbers 2,
8, 20, and 21 — concerned the pla
ning and organization. Responses r
flected a general approval of the w
the field staff and the coordinati
committee conducted the tour.

Items 5, 12, 14, and 15 were r
lated to the number of stations a
the sound quality. The low ranks
items 5, 12, and 15 — all of whi
were negatively couched statemen
— indicated satisfaction with the
multaneous program. According
the responses to question 14, t
sound transmission could have be
improved. Also, several of the fie
staff commented that the use of few
stations would have improved t
program. However, a larger audien
could be accommodated by using t

total TeleNet system than by limiting its use in any way.

Items 7, 11, and 16 concerned the conduct of the presentation. Responses to number 7 indicated that the flow of the program might have been altered. However, the correlation of the slides with the narration seemed to be the important consideration rather than the pacing of the presentation.

Items 17, 19, and 22 concerned the use, quality, and effectiveness of :he visuals. Responses indicated that :he field staff approved of the use of ;lides. However, the staff was not :ompletely satisfied with the visual-zation of the important concepts. This may have been due to failure of the local coordinator to have the proper visuals on the screen at all imes.

The last two items required origi-ıal responses. These responses were ;enerally favorable to the tour. The nethods of calling for visuals and of ccepting questions received some riticism. Also, it was suggested that he farms selected for the tour were typical.

Another criticism was that audi-nce participation was limited. But onsidering the scope of the material overed, depth of coverage, and the etail that was possible with the nethods used, it is doubtful whether ny walking tour could have accom-odated as many people as did the 'eleNet tour. It is interesting that ver 200 audience questions were an-vered for all participants to hear.

The scale for the audience was sim-ar to the one for the field staff, but as shorter. The form was completed ıd returned by 629 of the tour par-:ipants. Responses indicated general tisfaction with the tour. Particularly rong agreement was expressed with e following statements: "I was able hear without difficulty," and "I ɔuld recommend future farm man-ement tours using this method." ıere were also many favorable writ-ı comments.

We feel that the response to this st TeleNet tour provides a sound sis for planning future major Tele-:t programs.

Body of the Attitude Scale Used with Professional Extension Field Staff

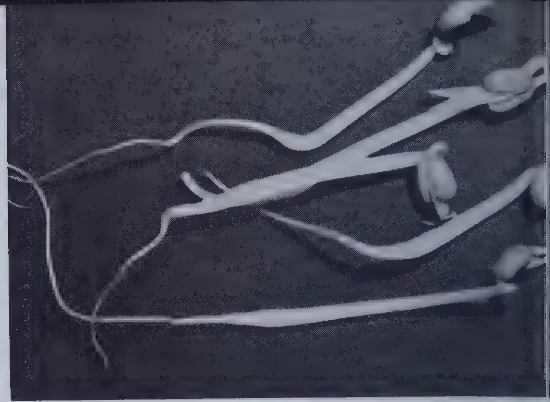
Statement	*Summated total*	*Rank*
1. I felt the instructional staff was interested in the welfare of the audience.	252	1
2. The local committees were left with too much detail work.	194	15 T
3. I felt I knew what to expect when I arrived for the tour.	230	4
4. I think my clients were satisfied with the tour.	216	8
5. The number of stations taking part in this program seriously hampered this program.	189	18
6. My impression of the future of any type of remote teaching altered toward the positive side due to this experience	206	12
7. In general, the subject matter was presented too slowly.	201	13
8. The university staff should educate the advisers and fieldmen and let them conduct such programs.	168	21
9. I would recommend future farm management tours via TeleNet.	227	5
10. Personally, I was satisfied with the total program.	211	10
11. The sessions were too long between breaks.	214	9
12. The number of simultaneous stations on a given program should be limited.	193	17
13. The content of the tour program was relevant to the informational needs of my clients.	222	6
14. The sound quality for the program was as good as could be expected.	194	15 T
15. The difficulty of responding precluded any adequate discussion.	155	22
16. Electing spokesmen for the group worked out well.[a]	185	19
17. The use of the slides was a good technique.	240	2
18. TeleNet seems to be an effective method of reaching more extension clients with the same input of staff time.	220	7
19. The quality of the visuals was satisfactory.	238	3
20. I felt the information preceding the tour for the local staff was adequate.	207	11
21. The local committees should have had more opportunity to take part in the planning.	174	20
22. The visualization of the concepts was well prepared.	198	14

23. What type of materials and information would you like to see prepared to assist in follow-up of this tour?__________

24. In planning future TeleNet programs I would recommend__________

[a] Question 16 was deleted from the analyses as some groups did not select a spokesman.

Mung Beans and Their Sprouts Are Palatable and Nutritious



Beans can be sprouted at home in 4 days' time.

FA-MEI C. HSUEH, AIKO K. PERRY, and FRANCES O. VAN DUYNE

WITH THE GROWING popularity of Chinese food, many Americans are becoming familiar with mung beans (*Phaseolus aureus* Roxb.).

These small, round green beans are used extensively in the Orient. When sprouted, they serve as an important fresh vegetable. Sprouted beans are one of the principal ingredients in chop suey, chow mein, and other Chinese entrées. Mung beans are considered a good source of thiamin, and the sprouts are reported to contain ascorbic acid.

Since mung bean sprouts are perishable, most of those produced in the United States are canned, and only rarely are fresh sprouts found on the retail market. However, as shown by a recent study in the Department of Home Economics, it is relatively easy to sprout beans at home and to use them in preparing salad and entrées.

The study was undertaken to investigate both the feasibility of preparing palatable bean sprouts at home and the effects of refrigerator storage and cooking on ascorbic acid and thiamin content, as well as on palatability. Mung bean sprout salad and sprouts sautéed with pork were selected for the evaluation of palatability. In addition, the desirability of substituting mung beans for peas in a recipe for split pea soup was studied.

How the beans were sprouted

Mung beans were purchased on the local market. They were carefully sorted and three 1-cup portions were weighed out to provide sufficient sprouts for one replication.

Fa-Mei C. Hsueh was formerly Research Assistant; Aiko K. Perry is Instructor in Foods; Frances O. Van Duyne, Professor of Foods.

After thorough washing with cold tap water, each portion was placed in 3 cups of lukewarm water and soaked for 16 hours. The soaked beans were rinsed and transferred to three, clean, 12-by-8-inch clay flower pots, the bottoms of which were lined with four layers of cheesecloth. The beans were spread evenly, watered thoroughly, and drained. The pots were kept in a kitchen cabinet at 65° to 75° F. away from light, since light causes the sprouts to become green and tough. The beans were watered four times a day for 4 days.

Then the sprouted beans were transferred carefully to a pan of water. With gentle stirring most of the green seed coats and some of the roots were washed off. The sprouted beans were removed from the water and drained. One portion was used for chemical determinations and for taste panel evaluation of the freshly prepared products and the other two portions were held in the refrigerator for 3 and 6 days before testing.

Four replications of these procedures were carried out.

Preparation methods

Sprouted beans with all the roots removed were used to prepare salad and were sautéed with pork. For salad, the sprouts were cooked in a large quantity of boiling water for 2 minutes, and drained. They were then marinated for 15 minutes in a dressing consisting of soy sauce, sesame seed oil, and vinegar.

To prepare sprouts sautéed with pork, meat from frozen pork chops was sliced into strips and dredged with a mixture of soy sauce and cornstarch for 10 minutes. The sprouts were sautéed quickly in corn oil seasoned with monosodium glutamate and removed from the skillet, afte which the pork strips were sautée with additional corn oil, soy sauce and water for 3 minutes. The sprout were then returned to the skillet an mixed with the pork and salt.

Mung bean soup was prepared b a modified recipe for split pea sour Water, a cube of salt pork, and dice onion were added to washed sorte beans. The mixture was boiled fo 2 minutes and simmered for 1½ hours. Then the salt pork was re moved and the remaining mixtur was put through a Foley Food Mil After being thickened with flour, th soup was seasoned and milk wa added. The soup was then cooled an frozen in freezer jars. Enough sou was prepared in each of four replica tions for evaluation when fresh an after 2 and 4 months of freezer sto age and reheating.

Palatability of the products

Five members of the food researc staff rated the salad, the sprou sautéed with pork, and the soup c the basis of appearance, color, te ture, and flavor. The salad also w rated for off-flavor. All characteristi were scored on a 5-point scale wi 5 corresponding to very good; good; 3, fair; 2, poor; and 1, ve poor. Total scores were obtained b adding scores of all the factors rate Mean scores for individual pala ability factors and mean total scor for the three products are given Table 1.

The salad prepared with precook fresh sprouted beans received a tot mean score of 24.0 of a possible points, indicating a very palatab product. Salads prepared after t sprouts were refrigerated for 3 and days had mean total scores of 2

Table 1. — Mean Palatability Scores for Mung Bean Sprout Products and Mung Bean Soup

Products nd treatments	No. of ratings	Mean scores: Appear-ance	Color	Texture	Flavor	Off-flavor	Mean total scores	Possible total scores
prout salad								
Fresh, cooked 2 min...	20	4.9	4.6	4.8	4.7	5.0	24.0	25
Refrigerated 3 days, cooked 2 min......	20	4.8	4.5	4.7	4.6	4.9	23.5	25
Refrigerated 6 days, cooked 2 min......	20	4.6	4.2	4.8	4.5	4.8	22.9	25
prouts sautéed with pork								
Fresh, sautéed......	20	4.2	4.8	4.8	4.8	...	18.6	20
Refrigerated 3 days, sautéed.........	19	4.2	4.4	4.5	4.4	...	17.5	20
Refrigerated 6 days, sautéed.........	20	3.9	4.1	4.6	4.6	...	17.2	20
oup								
Freshly cooked......	20	4.8	4.8	4.8	4.8	...	19.2	20
Cooked, frozen, stored 2 mo., reheated...	20	3.8	4.6	4.4	4.3	...	17.1	20
Cooked, frozen, stored 4 mo. reheated....	16	3.5	4.0	3.9	4.0	...	15.4	20

Table 2. — Mean Values for Moisture, Ascorbic Acid, and Thiamin Content of Mung Bean Sprouts

mple treatments	Moisture	Ascorbic acid: As determined	Ascorbic acid: Retention	Thiamin: As determined	Thiamin: Retention
	pct.	mg./gm.	pct.	mcg./gm.	pct.
w					
Fresh..........................	85.7	0.22	100	1.46	100
Refrigerated 3 days.............	84.7	0.20	84	1.44	93
Refrigerated 6 days.............	83.5	0.19	75	1.41	84
ooked 2 min.					
Fresh..........................	87.2	0.10	48	0.90	69
Refrigerated 3 days.............	86.0	0.07	31	0.87	62
Refrigerated 6 days.............	84.6	0.04	19	0.82	53

Table 3. — Mean Values for Moisture and Thiamin Content of Mung Bean Soup

Sample treatments	Moisture	Thiamin
	pct.	mcg./gm.
Freshly cooked.........	88.0	0.60
Cooked, frozen, stored 2 mo., reheated........	86.8	0.59
Cooked, frozen, stored 4 mo., reheated........	85.5	0.61

ıd 22.9, respectively, which corre- onded to ratings of high good.

Fresh sprouts sautéed with pork ıd a total mean score of 18.6 of a ıssible 20 points, corresponding to gh good. When this product was epared with sprouts that had been frigerated 3 and 6 days, the scores ere 17.5 and 17.2, respectively. Al- ough these scores corresponded to a od rating, the panelists commented at the refrigerated sprouts were ghtly bitter.

When freshly prepared, mung bean ıp was rated high good in every aracteristic and received a total ean score of 19.2. After 2 months freezer storage and reheating, the ıp was rated good; and after 4 onths of storage, high fair. Freezer storage and reheating decreased the palatability — the soup was slightly separated and more bland in flavor, especially after 4 months of storage.

Moisture and vitamin contents

Mean values for the moisture, thiamin, and ascorbic acid content of raw and cooked sprouts when freshly harvested or after refrigeration are presented in Table 2.

Refrigerator storage caused small but significant decreases in moisture content. Significantly more moisture was lost from sprouts held for 6 days than from those held for 3 days.

The ascorbic acid contents of raw sprouts when fresh, held 3 days, and held 6 days were 0.22, 0.20, and 0.19 milligrams per gram. Upon statistical analysis, the difference between the ascorbic acid contents ("as determined" basis) of the fresh and held samples was found to be significant.

A significant amount of ascorbic acid was also lost during cooking, the loss increasing with the length of refrigerator storage before cooking. Sprouts refrigerated 6 days and then cooked retained only 19 percent of the ascorbic acid originally present in the fresh raw samples.

The raw sprouts retained thiamin better than they did ascorbic acid during refrigerator storage. The thiamin content (on the "as determined" basis) declined from 1.46 to 1.41 micrograms per gram during 6 days of storage.

A significant loss of thiamin occurred during cooking. Mean thiamin retention was 69 percent in cooked freshly harvested sprouts; 62 percent in sprouts held 3 days and cooked; and 53 percent in those held 6 days.

The soup lost a significant amount of moisture after freezer storage and reheating (Table 3). However, the thiamin content ("as determined" basis) was virtually unchanged.

Mung beans have advantages

Homemakers can grow mung bean sprouts at any time of the year and use them in making palatable products. If the sprouts cannot be used immediately after harvest, they can be held for short periods in the refrigerator. Although the sprouts are only a fair source of ascorbic acid, they are a good source of thiamin.

Dried mung beans can be substituted for split peas in making soup that can be frozen for 4 months without appreciable loss of thiamin or marked decrease in palatability.

Introducing Illini Spinwheel, An Airy New Chrysanthemum

JOHN R. CULBERT

ILLINI SPINWHEEL, the most recent of the Illini chrysanthemums, was introduced to the florist industry last fall as "a potful of pinwheels." This nickname aptly describes the novel effect achieved by the profusion of daisy-like flowers.

Illini Spinwheel was bred and developed by the author in the floriculture greenhouses of the Department of Horticulture. It is the first of its type to be developed and introduced. A single row of white tubular ray florets, each ending in a clearly defined "spoon," encircles the dome-shaped yellow cluster of disc florets in the center of the flower.

The flowers are small, 2 to 2½ inches in diameter, but this small size and the loose arrangement of the white ray florets give the plant its dainty, airy effect. Each branch terminates in a cluster of five or six flowers so that a typical single plant may produce 20 to 30 flowers. These flowers are closely backed with abundant, deep green foliage.

Breeding and trialing

Illini Spinwheel was bred in 1964. Its parents were selected with the goal of developing a small, compact, bushy plant which would be covered with small dainty flowers. We envisioned that such a plant would be ideal for sale at a relatively low price in supermarkets, variety stores, or garden centers. Its small size would permit it to be displayed in the kitchen window, for example, and its price would put it within the reach of most shoppers. With the long-lasting qualities of potted chrysanthemums, such a plant would give two or more weeks of satisfaction in the home. Its size would also make it ideal for the hospital room.

John R. Culbert is Professor of Floriculture, Department of Horticulture.

Of the several thousand seedlings resulting from the crosses made in 1964, Illini Spinwheel (known then as seedling 411-10-64) was among the best. In February, 1967, a few cuttings of this and several similar seedlings were sent to Yoder Brothers, Barberton, Ohio, the world's largest propagators of chrysanthemums. After three years of rigorous trialing, Yoder Brothers were convinced that seedling 411-10-64 was a valuable plant with a bright future.

Meanwhile, our trials continued at Urbana, and flower growers and buyers alike were almost unanimous in their enthusiasm. With the universally good results in the trials, the decision was reached to introduce the plant under the descripitive name of Illini Spinwheel. So, on October 4, 1971, seven years after it was bred, the public career of Illini Spinwheel began.

Cultural details

Illini Spinwheel should be grown only as a spray pot with the center bud of each spray of buds rolled out (dissprayed). The plants should be grown pinched and average seven breaks per plant. A 6-inch pot with five pinched plants may produce from 80 to 100 flowers. Height may be controlled by regulating the number of long days or by applying a growth regulator such as B-9. One B-9 application of 2,500 ppm should give adequate height control.

Timing or treatment of Illini Spinwheel depends on the size of plant desired. For short plants, use the tall treatment (grow for 1 week with long days, 1 week with short days, pinch, and continue short days). For larger, taller plants, use the medium treatment (grow for 2 weeks with long days, pinch, and start short days). Use the tall treatment for all

plants flowering in late summ (August through October) in t north.

When grown north of 40 degre latitude, Illini Spinwheel will gi an early 8-week response in Ap through July; a mid-8-week respon in August, September, and Decen ber; and an early 9-week respon in October and November. It shou be provided with good fan and p cooling in the heat of summer. Co finishes (below 60° F.) will cau the white florets to tinge pink. T plant is not recommended for flow ing in the north from Janua through March.

Use of Illini Spinwheel

Illini Spinwheel is not suggest as a garden variety for Illinois. Wh grown out of doors, its flowering da of October 29 is so late that the bu and flowers are usually destroyed frost.

This variety is recommended as attractive novelty to be grown limited quantities at first to sam the potential market. Perhaps greatest potential is as a single pl in a 4-inch pot, although it w probably find a limited market wh grown in 5- or 6-inch pots. Ill Spinwheel will probably find greatest immediate use in north Europe, where the demand for su a plant already exists. It is anti pated that Illini Spinwheel will h to develop a demand for this sort plant in the United States.

Susceptibility of Soils to Splash Erosion Varies With the Percentage of Clay

G. D. BUBENZER and B. A. JONES, JR.

THE TOTAL amount of soil lost by erosion depends upon two distinct processes: splash erosion and sur-ice runoff.

Splash erosion is due to the impact of the raindrop n the soil surface. Each drop, falling as a tiny pro-ctile, breaks small particles from the soil mass. These articles may then be removed by surface runoff, which ccurs whenever the infiltration and storage capacities ' the soil have been exceeded. In a well-aggregated soil, lash erosion determines, to a great extent, the amount ' soil available for transport from a given area. Surface moff determines how much is actually removed.

In a recent study we investigated the effects of rain-ll characteristics on the rate at which particles were etached from four soils: Darwin silty clay, Cisne silt am, Flanagan silt loam, and Hagener loamy sand.

Rainfall was produced in the drop tower on the Uni-ersity farms at Urbana (Fig. 1). Drops were formed by ypodermic needles in the module hanger and fell onto il samples on a rotating table. The impact velocity id kinetic energy of the drops were determined by the ight of modules above the sample. The maximum dis-nce of fall was about 30 feet, which allowed the drops closely approach terminal velocity before striking the il surface. Drop size was controlled by varying the size the hypodermic needles.

Four samples of each soil type were placed in pans at were 3 inches in diameter and had porous bottoms permit drainage (Fig. 2). The pans were slowly ro-ted under the simulated rainfall so that the drops uld not continually impact at the same point.

At low kinetic energy levels, the mean splash erosion te was influenced by drop size. Large drops produced nificantly more splash than small ones, given the same netic energy, total rainfall mass, and impact velocity. e influence of drop size decreased as the energy level creased. At high energy levels, all drops produced about e same splash.

According to both visual observation and data analysis, critical energy level was required to cause a significant l splash. This critical level varied from one soil type another, increasing with average size of soil particle. e percent clay in the soil was therefore the most im-rtant physical property in determining soil splash. Of four soils in the study, Hagener loamy sand, with the st clay and the largest average particle size, had the atest critical energy level. Darwin silty clay, with smallest particle size, had the lowest level.

D. Bubenzer is a former Instructor; B. A. Jones, Jr., is Professor of icultural Engineering.

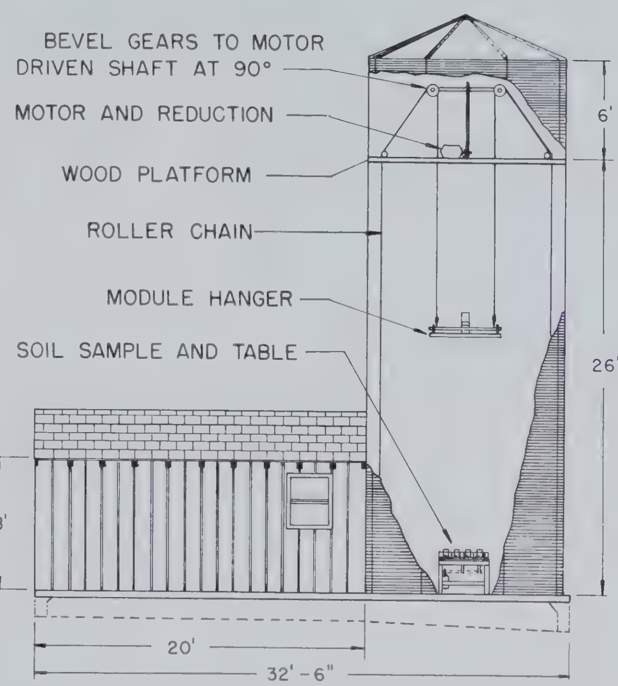
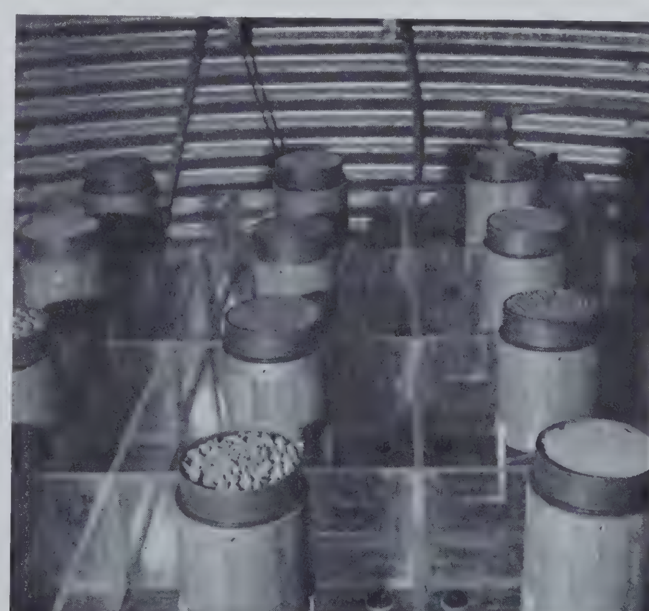
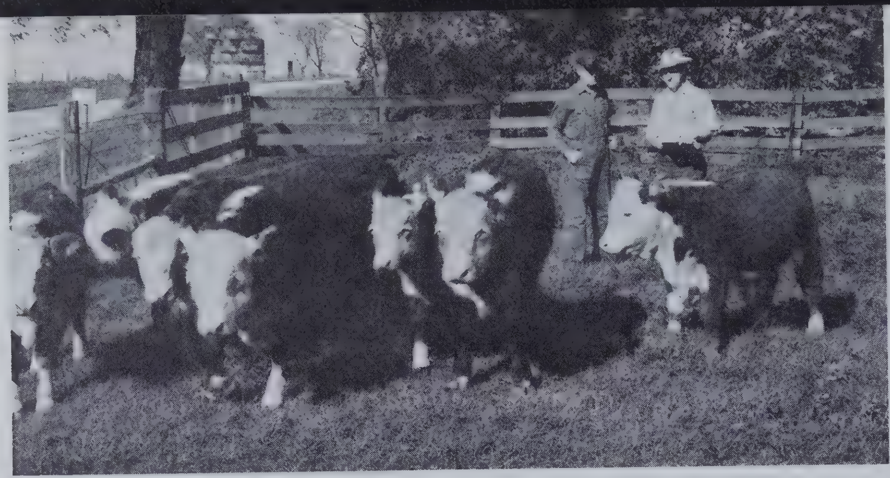


Diagram of drop tower on the University farms, where the simulated rainfall is produced. (Fig. 1)



Pans with soil samples are placed on a rotating table beneath the module hanger where drops are formed. (Fig. 2)



Studying records and evaluating bull calves for performance-tested bull sales. (Fig. 1)

Beef Performance Testing in 20 Western Illinois Counties

RICHARD H. SIMMS

ILLINOIS cattlemen have participated in beef performance testing since the mid-1950's, when the program was inaugurated by the livestock division of the Cooperative Extension Service.

In the 20-county western Illinois area, interest developed rather slowly at first. However, it picked up in the 1960's, especially at the end of the decade (Fig. 2). This increased participation has come from owners of both commercial and purebred herds. The western area now accounts for about a third of the beef performance testing in the state. Numbers of calves weighed in this area, by breed, from 1963 to 1970 are given in Table 1.

Beef performance testing, western Illinois and entire state, 1963-1970. (Fig. 2)

Table 1. — Numbers of Calves Weighed in Western Illinois, 1963-1970

Breed	Number	Percentage
Angus	9,530	42.6
Hereford	9,068	40.5
Shorthorn	2,245	10.0
Other	1,539	6.9

Untiring promotional efforts by extension personnel are one reason for the increased participation. Another reason has been the need for accurate culling practices in achieving economical herd returns. A third reason has been the development of the Illinois beef performance tested bull sale. And finally, the recent changes in desirable body type have also stimulated interest in performance testing records.

The performance testing program consists of three phases:

1. Individual calf weight and quality are measured during the 5- to 9-month weaning period. Since calf evaluation indicates the cow's milking and "mothering" ability, weaning records can be used to cull inefficient cows from the herd (Table 2).

Richard H. Simms is Area Extension Adviser in western Illinois, specializing in livestock.

Table 2. — Variation in Productivit of Cows in Typical 80-Cow Herd

	Weaned wt., lb.	Calf quality
Herd av.	447	Average to High Choi
Top 15%	521	High Choice to Low Prin
Low 15%	376	Low to Average Choic

Table 3. — Effect of Sire on Calf Gains in Typical Herd

Sire	Av. daily gain after weaning, lb.	Av. total l 160 day
A	1.32	211
B	1.68	269
C	1.85	296
D	1.47	235
E	1.97	315

Table 4. — Average Effects of Sir on Carcass Traits Within a Herd[a]

Sire	Live 365-day wt., lb.	Dressing pct.	Rib eye per cwt. of carcass, lb.	Carcass wt. per day of age, lb.	Ac 20 dc w lb
F	991	61.8	1.78	1.12	4ٍ8
G	1,111	59.1	1.82	1.30	48
H	1,186	61.6	1.63	1.36	54
I	1,128	60.6	1.71	1.29	56
J	1,183	60.4	1.67	1.38	5:
Av.	1,120	60.7	1.72	1.29	5:

[a] These results indicate that calves sired by ' and "J" are genetically superior in live weight g and in carcass weight per day of age.

2. The inherent growth ability cattle from weaning until the 11- 13-month yearling weight-measu ment period is determined. Produc have used post-weaning performa records to evaluate sires and sel superior herd replacements (Ta 3).

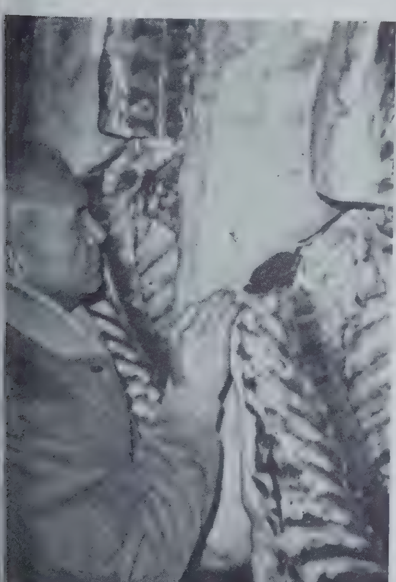
3. The beef carcass is evalua (Fig. 3). Results are helpful in co paring and selecting sires (Table

The massive job of accura calculating individual weaning yearling weights, average sire or h weight, and quality values is co pleted with the aid of a compu Weaning weights have to be adjus for (1) age of the dam, becaus the effect on milk production; (2) sex of the calf, because of h monal effects on growth rate.

Differences in weaning weight due to creep feeding or to season of oirth are not computed. When select-ng herd replacements, however, herd owners must judiciously consider these factors in addition to items such as individual animal temperament and physical soundness.

Data from the performance testing program are made available to par-icipating producers for use in main-aining progressive beef production programs. With the rapid expansion of beef cow numbers in western llinois, it is imperative that cattle-nen manage their operations with itmost efficiency.

Several successful cow herd own-rs in western Illinois have similar bjectives in their management pro-rams: (1) Maintain herd health, vith emphasis on disease prevention nd parasite control. (2) Develop an conomical feeding program which rovides essential nutrients to varying ge groups. (3) Establish an accurate ecord-keeping system based on the eef performance testing program. 4) Initiate an animal identification stem based on such devices as freeze rands and ear tags. (5) Utilize nly superior sires to constantly in-rease the genetic potential of the erd. (6) Constantly cull low-pro-ucing animals.



f carcasses are evaluated according to group. (Fig. 3)

Common Purslane—A Problem in Gardens and Horticultural Crops

H. J. HOPEN

IN SOME countries common purslane (*Portulaca oleracea* L.) is a salad vegetable, but in most areas of the world, this prostrate, succulent plant is generally considered a weed.

In Illinois, common purslane is a problem in home gardens and in commercial horticultural crops, which have a high economic value per unit of area. The seed has been known to live in the soil for as long as 40 years.

The competitiveness of common purslane is partly related to its succulence, which makes it drouth-resistant and enables it to regenerate new roots after being cut off from the soil. These characteristics should enable it to compete with field crops as well as with truck and garden crops. However, it is not usually a problem in corn or soybeans.

Field and greenhouse studies were conducted to try to understand why this plant is adapted to certain cultural situations and not to others. The studies were carried out at Collinsville and at the University of Illinois Drug and Horticulture Experiment Station at Downers Grove.

One experiment concerned depth of seeding. It was found that common purslane seed, which is very small, cannot produce significant viable plants from soil depths greater than about ¼ inch. As would be expected from this result, a smooth, fine-textured seedbed favored the emergence of purslane seed. Most commercial small-seeded vegetable fields and most home gardens have finer textured seedbeds than the large-seeded field crops.

Nutrient level was found to have a great influence on purslane growth. An adequate level of phosphorus was especially important in the development of common purslane. This observation resulted from tests carried out under hydroponic conditions with carefully controlled nutrient step levels. Vegetable crop soils usually receive higher phosphorus applications than do field crop soils, so this is another reason why common purslane thrives better in vegetable crops than in field crops.

Picture courtesy Elamco Products Co.

In greenhouse studies, common purslane germinated and grew better at a soil temperature of 90° F. than at 80° F., and better at 80° F. than at 70° F. This explains why preemergence herbicides are not completely effective in controlling common purslane. Because of the high temperatures required for germination, the weed does not become a problem in most of Illinois until June. By this time, much of the preemergence herbicide effect may have dissipated and the weed growth is relatively unchecked.

Traditionally common purslane has had to be removed by cultivation and hand methods, which have added to the cost of crop production. Several postemergence herbicides, which are currently in various stages of development and use, will control common purslane in commercial crops with a high unit value.

H. J. Hopen is Associate Professor of Vegetable Crops, Department of Horticulture.

What's New in Teaching Agriculture

K. E. GARDNER

AGRICULTURAL instruction — just like agriculture in general — is dynamic and ever-changing.

One change in the College of Agriculture has been a 30-percent increase in enrolment over the past 10 years. Much of this has been due to increased numbers of transfer students from junior colleges and other schools in the state. The number of freshmen in agricultural courses has remained relatively unchanged.

Much more significant than the change in enrolment, however, are the changes in the agricultural curricula, some of which are discussed briefly in the following paragraphs.

Two travel courses

During spring vacation this year, some 40 students took part in a new type of traveling field trip. Accompanied by two professors, the students spent 10 days visiting ranches, feedlot operations, poultry farms, packing houses, and other points of interest in Missouri, Kansas, Oklahoma, Texas, and Arkansas.

The students found this travel course extremely worthwhile, and plans are to repeat it in other years. Offering the course during spring vacation rather than in the summer has the advantage of not interfering with possible summer jobs.

Another travel course will be offered this summer in cooperation with Purdue University. The course will provide an opportunity to study tropical agriculture in Venezuela, Colombia, Costa Rica, and Honduras. Students will be drawn from the University of Wisconsin, University of Minnesota, and Michigan State University, as well as from Illinois and Purdue.

This course has been offered by Purdue in previous years, and will be conducted by a professor in the Agronomy Department of that institution. It will provide 5 semester hours of credit and will cover a total of 6 weeks, including a week of preparation before the trip and a week of report writing and summary afterwards.

Students will see some of the agricultural problems in Latin America and observe crops being grown — including coffee, bananas, cocoa, sugar cane, and other exports to the United States. Trade, economic problems, political organization, geography, climatology, history, culture, and religions of Latin America will be covered in the discussions. Many institutions of the host countries will cooperate in the program.

Exploratory courses

A student may now actually initiate a new course that he would like to see offered. All he has to do is induce a professor to teach the course, and corral enough other students to make the course offering economical. The course can then be given almost "without warning," and without any red tape. If it proves successful, it is later approved through customary channels, and its content is officially recorded.

Special problems courses

Throughout the academic world, considerable interest has developed in allowing a student to take courses which have unusual relevance to some public problem or to a problem of a specific industry. For 25 years, the College of Agriculture has encouraged students to engage in "relevant" research. The student is permitted to describe a specific problem and find a professor who is interested enough in the same question to guide the student's research and certify that it meets certain academic standards.

The research may be done either on or off campus. The student is required to write a report, which provides one basis for evaluating hi[s] accomplishments and assigning [a] grade.

Relevance in course work

A considerable hubbub across th[e] country has protested the "irrele[-] vance" of much University work[.] Some of this can be scratched off a[s] "anti-intellectualism." At the sam[e] time the protests cannot be ignored[.]

No one can be absolutely certai[n] as to the degree of relevance o[f] many courses, for this often depend[s] on what a young man or woman wi[ll] do after graduation. However, for [a] student who plans to farm, it woul[d] be difficult to find a more relevan[t] course than a farm managemen[t] course in which the student is ex[-] pected to use his own home farm a[s] his "problem." Tours to large pro[-] cessing plants or farm equipmen[t] manufacturers are highly relevant t[o] a student who plans to enter thes[e] industries. An understanding of so[il] analysis is very useful to a youn[g] man who plans to go into extensio[n] work or into the field of agricultura[l] chemicals.

On the other hand, the relevanc[e] of basic inorganic chemistry for stu[-] dents who plan to farm or to follo[w] a career in agricultural journalism [is] not so easy to determine. Perhaps w[e] have not attacked the question co[r-] rectly. When we questioned the teach[-] ing staff, we were amazed at ho[w] few of them considered basic chem[-] istry of great significance in the[ir] courses. This opinion, which wou[ld] have been considered rank heresy [...] years ago, may reflect our changin[g] attitudes toward "relevance."

Computers in instruction

Another new trend is the use [of] computers in instruction. At prese[nt] they are being utilized in some [...] courses, and the possibility of th[eir] further use in didactic or "memor[y"] courses is being examined.

K. E. Gardner is Associate Dean and Director of Resident Instruction.

Five Staff Members Win Funk Awards

FIVE College of Agriculture staff members have received cash ıwards in the second annual Paul ٨. Funk Recognition Program. These ıwards are provided by the Paul A. ⁷unk Foundation of Bloomington "to ecognize outstanding performance ınd high achievement among the aculty of the College of Agriculture t the University of Illinois."

Recipients of the awards were anıounced March 3. The major reasons or which each recipient was honored re briefly described in the following aragraphs.

onald Eugene Becker

Dr. Becker has profoundly influnced the U.S. swine industry ırough his research, teaching, and ctension work. Perhaps his most gnificant contribution has been the ioneering research that led to the evelopment of complete swine raons using corn and soybean meal.

His innovative approach to swine ıdustry problems was illustrated hen he and his associates developed ıe concept of totally confined swine roduction systems. Total confineent is now being used by swine oducers throughout the world.

As a faculty member and as head the Department of Animal Science ıce 1967, Dr. Becker has placed gh priority on working with stunts and developing educational ograms.

His work with pork producers inıdes a key role in the formation of e Illinois Pork Council, which repsents most of the progressive pork oducers in the state and firmly suprts the College's extension, instrucn, and research programs.

nald James Bray

An outstanding teacher, Dr. Bray s skillfully integrated research into teaching program in poultry scie. As a result of his research-oried approach to teaching, several his undergraduate students have completed research projects and published their findings.

Dr. Bray was one of a team of University of Illinois animal scientists who developed a series of autotutorial units now used to teach animal science in nearly 60 other colleges.

Dr. Bray's research on corn-soya diets has led to more efficient use of the state's corn and soybean crops in poultry feeding. His photo-stimulation studies point out that proper lighting programs can maximize the use of corn and soybean protein in commercial egg production. In addition, Dr. Bray is the only investigator known to have identified the optimum heat for treating raw whole soybeans for use in poultry rations.

Ambrose William Burger

Dr. Burger is one of the nation's leading innovators in the teaching of crop science. He pioneered in the use of television to bring into the classroom instructional resources that could not be made available in any other fashion.

His desire to improve student instruction prompted him to take on the huge task of converting his field crops laboratory to a completely autotutorial laboratory that serves more than 100 students a semester. He has also produced a series of 13 autotutorial teaching units to be used in conjunction with laboratory manual and specimens. Nearly 60 institutions of higher learning are now using all or part of the materials he has developed.

Dr. Burger is also noted for research on the prussic acid content of Sudangrass and sorghum-Sudangrass hybrids, as well as for pasture and grazing management investigations.

Andrew Vladimir Nalbandov

Dr. Nalbandov has earned international respect for his research on physiological and endocrinological phenomena associated with reproduction. His approach is comparative, involving a wide variety of species, but the emphasis has always been on poultry, sheep, swine, and cattle. Much of his work is basic to the improvement of female fertility.

Areas in which he has made significant research contributions include: sterility and embryonic mortality in female pigs; factors influencing induction of ovluation; formation and maintenance of corpora lutea in swine, cattle, and sheep; and the endocrinology and physiology of reproduction in chickens.

Dr. Nalbandov has supervised the doctoral programs of some 45 students, who are now working in nearly every aspect of research, teaching, extension, and industrial application of knowledge in reproductive physiology.

Fred Warren Slife

Dr. Slife has earned renown for his skills in recognizing weed control problems, in conducting fundamental and applied research on these problems, and in finding effective and practical solutions. He has been one of the world's leaders in establishing the systematic study of weeds and weed control as a true science.

Dr. Slife's research on weed competition has probably been quoted more often than any other single weed research completed during the early 1960's. This research was instrumental in the adoption of preemergence herbicides by a large percentage of farmers during the past decade.

He concentrates on studying the life history, morphology, and physiology of specific weed species, and developing cultural and chemical controls on the basis of these studies.

Dr. Slife has been an effective teacher and adviser. His extension activities have included participation in the annual Illinois Custom Spray Operators' Training School.

FARM BUSINESS TRENDS

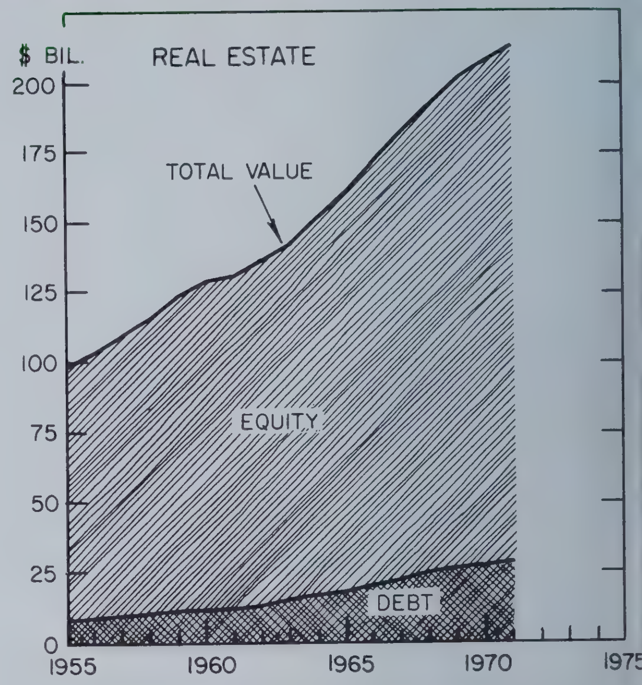
FARMERS get deeper into debt almost every year. So why have they continued to farm or to own farmland? One reason may be that their assets have increased faster than their debts. This has been especially true for landowners.

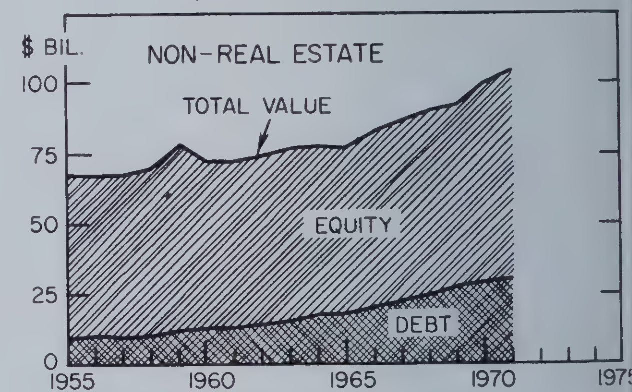
According to figures compiled and published by the U.S. Department of Agriculture, the debt on U.S. farm real estate increased from $8.2 billion on January 1, 1955, to $29.5 billion on January 1, 1971. The increase totaled $21.3 billion. During the same period the total value of farm real estate increased from $98.2 billion to $214 billion, for a total increase of $115.8 billion. Owners' equity in farm real estate went up from $90.0 billion in 1955 to $184.5 billion in 1971. (This increase does not include the amount received from the sale of farmland for non-agricultural purposes.)

Non-real estate farm debt increased markedly during the past 16 years, rising from $9.4 billion in 1955 to $31.6 billion in 1971. At the same time the total value of non-real estate farm assets went up from $66.9 billion to $104.9 billion. Farmers' equity in non-real estate farm assets climbed from $57.5 billion to $73.3 billion.

Not all farmers have shared in the increased equity in farmland and other farm property. Some farmers, especially in Illinois, own little or no land. A substantial number of farmers have seen their equities shrink. Some farmers, like other businessmen, have been forced to quit.

While farmland has steadily increased in value for nearly four decades, there is no guarantee that prices will not decline during the years ahead. Indeed, it would be reasonable to expect that land values, like prices of corporation stocks, will decline at times even though the long-time trend may be upward. — *L. H. Simerl, Professor of Agricultural Economics*





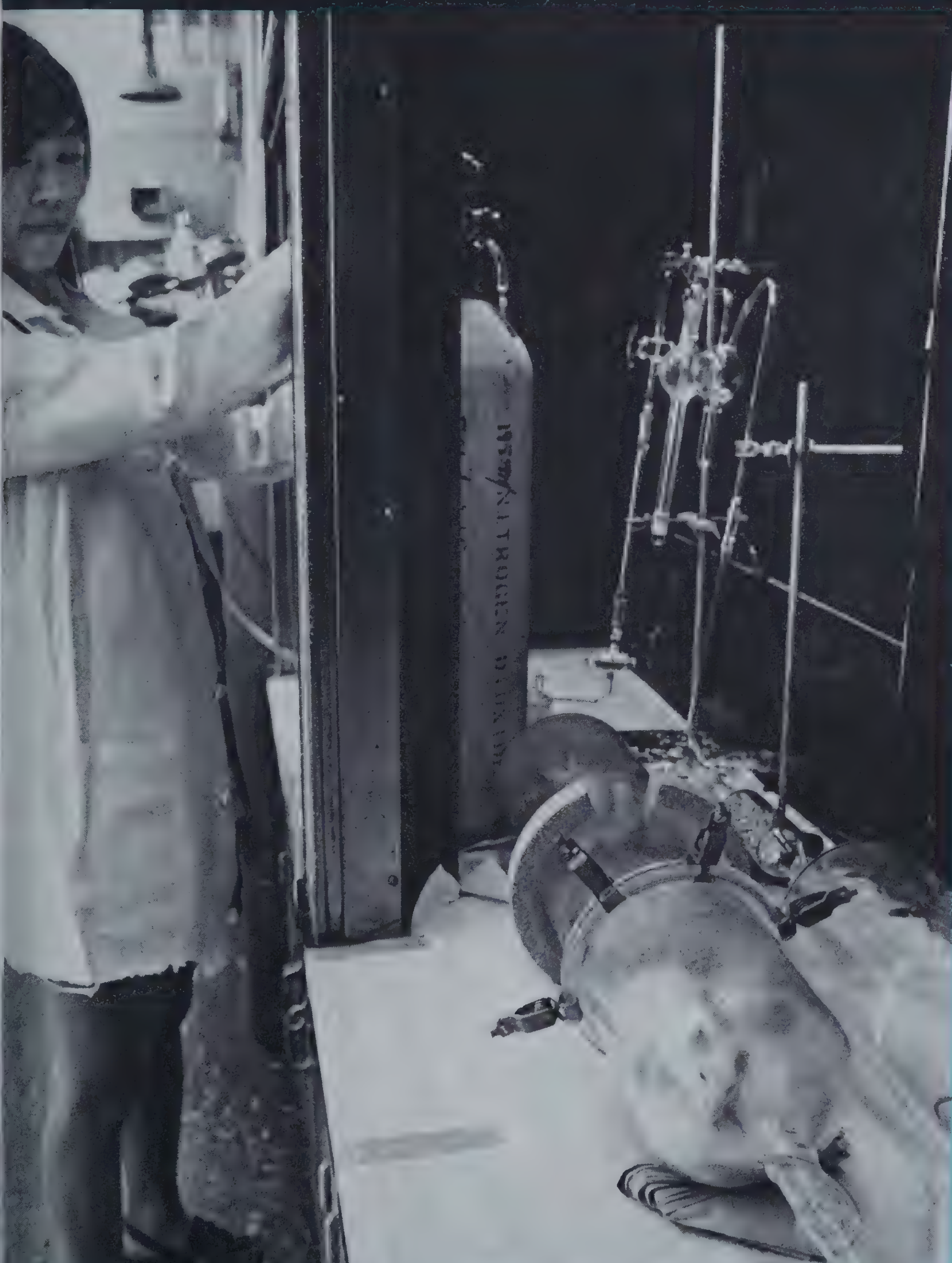
Total value, owner's equity and debt in farm real estate and non-real estate, 1955-1971.

UNIVERSITY OF ILLINOIS · AGRICULTURAL EXPERIMENT STATION
Urbana, Ill. 61801 · G. W. Salisbury, Director · Publication · 13M

Summer, 1972

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station



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Rats are exposed to nitrogen dioxide in gas inhalation chambers to study effects of air pollution on the aging process (page 3).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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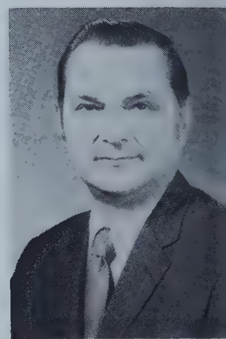


NEW HEAD OF FOOD SCIENCE

ARTHUR J. SIEDLER assumed his duties as head of the Departme
of Food Science in March, coming to Illinois from the Norwi
Pharmacal Company, Norwich, New York. He had been
Norwich since 1964, serving as group leader in Special Biolo
until 1965; chief of the Physiology Section from 1965 to 1969; a
chief of the Biochemistry Section from 1969 to 1972.

His previous professional experience was with the American Me
Institute Foundation of the University of Chicago. He joined
staff after receiving his B.S. degree from the University of Wisco
sin in 1951. By 1959 he had advanced to the position of chief
the Division of Biochemistry and Nutrition, and had also receiv
his M.S. and Ph.D. degrees from the University of Chicago. Fro
1960 to 1964 he held a joint appointment with the University
Chicago and the Meat Institute Foundation.

Dr. Siedler says that the Department of Food Science is at prese
"evaluating where we are now and where we are going from her
Food science, he points out, is not one discipline, but a multidis
pline, encompassing food processing engineering, food chemist
food microbiology, and nutrition. He expects that the departmen
multidisciplinary capabilities will be focused on answering the qu
tions about processed foods that will probably arise during the ne
decade. Such foods now constitute most of the American diet, a
food science is charged with the responsibility of seeing that they a
wholesome and nutritious.

In addition to his administrative duties, Dr. Seidler looks forwa
to doing some teaching and research. He is particularly interest
in studying the mode of action of vitamin K, one of the many su
jects on which he has already conducted some investigations.

— *G. W. Salisbu*

Air Pollution and Aging

Nitrogen dioxide and ozone in polluted air may accelerate the aging process by affecting fatty acids in the body

A. SAARI CSALLANY

THE QUALITY of the air we breathe is as important for our health as the quality of the food we eat or of the water we drink. For a long time mankind took clean air and water for granted and seldom seemed concerned about their quality. Air, especially, seemed to be limitless. Only in the past few decades have we become increasingly aware that the air which surrounds us can be polluted to the level where it can endanger our health.

During the early part of the twentieth century the major cause of air pollution was coal smoke, and in many areas of the world it is still the dominant concern. In most industrialized countries, however, petroleum and natural gas have largely replaced coal as a source of energy. The use of petroleum products has been tremendously accelerated by the almost exclusive use of internal combustion engines in highway, railway, marine, and air transport.

While greatly reducing coal smoke, the combustion of petroleum products and gases has replaced one problem with another. The first serious community air pollution problem in the United States — the Los Angeles smog — was definitely attributable to the use of petroleum products.

Pollutants in the air

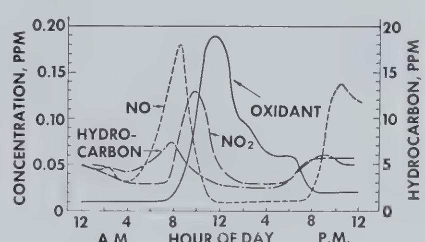
Actually, smog is neither smoke or fog. The complex reactions involved in its formation are not completely understood. We do know, however, that polluted air contains relatively high concentrations of sulfur dioxide (SO_2), nitrogen dioxide (NO_2), nitric oxide (NO), and ozone

Saari Csallany is Assistant Professor of Nutritional Biochemistry, Department of Food Science.

Estimated Air Pollutants Emitted in the United States in 1965[a]

Sources	Carbon monoxide	Sulfur oxides	Hydro-carbons	Oxides of nitrogen	Partic-ulars	Total	Pct. of total
			Millions of tons				
Automotive	66	1	12	6	1	86	60
Industrial	2	9	4	2	6	23	17
Electric power	1	12	1	3	3	20	14
Space heating	2	3	1	1	1	8	6
Trash disposal	1	1	1	1	1	5	3
Total	72	26	19	13	12	142	100

[a] Source: *The Sources of Air Pollution and Their Control,* Public Health Serv. Pub. 1548, U.S. Dept. of Health and Welfare, Washington, D.C., 1966.



Variations in atmospheric concentrations of nitric oxide, nitrogen dioxide, and oxidant (scale on left of chart) and of hydrocarbon (scale on right) during the course of a smoggy day. (Fig. 1)

(O_3). Also present are many other gaseous products, such as traces of hydrocarbons, aldehydes, and other organic compounds.

Two of the most important pollutants are nitrogen dioxide and ozone, which are both highly oxidizing. Nitrogen dioxide is formed from nitric oxide with the aid of the sun's energy. Solar energy and oxides of nitrogen, as well as hydrocarbons, are also involved in ozone production.

Transportation accounts for about 60 percent of the pollution in the air (see table). Every 1,000 gallons of gasoline burned in city driving (at an average speed of 25 miles per hour) produces 2,400 pounds of carbon monoxide, 185 pounds of nitrogen oxide, and 132 pounds of hydrocarbons. It is not surprising, therefore, that concentrations of nitric oxide and hydrocarbons are highest after the morning and evening rush hours (Fig. 1).

After sunrise, nitric oxide in the air is converted to nitrogen dioxide with the aid of the sun's energy, and the complex photochemical reactions start producing ozone and other oxidants. The highest levels of nitrogen dioxide and ozone are found in polluted air between 9 a.m. and 3 p.m.

Most of the ozone and nitrogen dioxide in the air are due to pollution. However, some ozone and nitrogen oxides are produced in the upper atmosphere by solar irradiation, and small concentrations of these gases are transported to the lower atmosphere at the earth's surface. Unpolluted air generally contains up to 0.03 ppm of ozone and up to 0.01 ppm of nitrogen dioxide.

In contrast to unpolluted air, the air above major U.S. cities contains mean concentrations of 0.03 to 0.06 ppm of nitrogen dioxide. The maximum recorded daily averages in the various cities vary from 0.10 to 0.26 ppm; and the maximum 5-minute averages, from 0.24 to 0.79 ppm. The highest concentrations are found in

Rats and mice are exposed to varying degrees of air pollution in these environmental chambers and are fed diets containing three levels of antioxidants. (Fig. 2)

the Los Angeles and San Francisco areas, where the yearly mean in 1964 was 0.06 ppm.

Typical ranges for ozone in Los Angeles on a clear day are 0.05 to 0.30 ppm and on a smoggy day, 0.20 to 0.65 ppm. Maximum values range up to 0.90 ppm.

Health effects

The effects of air pollutants on man may be either acute or chronic. Acute effects develop rather rapidly — in minutes, hours, or several days — and are usually obvious to the affected individual. These effects range from nose and eye irritation, through pulmonary congestion, emphysema, edema, and pneumitis, to death.

Chronic effects are not necessarily detectable by the affected individual, but they can develop, sometimes cumulatively, over a long period, even an entire lifetime. The slow biochemical changes which may result from long exposure to low concentrations of nitrogen dioxide and ozone are largely unknown. However, since these two gases are strong oxidizing agents, we do know that to live in polluted air is to live under unnaturally oxidizing conditions.

The possible danger in these oxidizing conditions could lie in their effect on the fatty acids in our bodies. These fatty acids occur largely as components of complex lipid materials, which can be found in many parts of the body, including cell membranes and subcellular organelles (such as mitochondria, microsomes, and lysosomes). Fatty acids can be saturated or unsaturated. The unsaturated acids tend to oxidize faster than the saturated ones.

A certain type of oxidation (known as peroxidation) of polyunsaturated lipids has been found to be associated with certain deteriorative reactions, such as the aging processes in cells and membranes. According to our present knowledge, the lipid peroxidation aging processes may develop as follows: (1) Peroxidation of polyunsaturated lipids causes molecular damage (through free radical intermediates) analogous to radiation effects. (2) Biological membranes and subcellular organelles are structurally damaged. (3) Proteins from the damaged cell parts react with the breakdown products of peroxidized lipids and form age (lipofuscin) pigments. These pigments can accumulate in the brain, heart, lungs, and other tissues of the body as a slow process of age. Their formation can be accelerated by a rare disease (neuronal ceroid lipofuscinosis). When this happens, they accumulate in the brain, causing brain deterioration and death. The age pigments are especially destructive to the young brain.

The question then arises as to whether the nitrogen dioxide and ozone in polluted air will affect lipid peroxidation and the formation of age pigments in the body. Might oxidizing air pollutants affect young children in urban areas, possibly altering their behavior and learning ability? Might these pollutants also contribute to senility in the old?

If the oxidizing pollutants do indeed affect lipid peroxidation, can we counteract their effects with antioxidants? Vitamin E and some other biological antioxidants and reducing compounds can stabilize polyunsaturated lipids and minimize damage due to lipid peroxidation. Nonbiological relationships have been established between unsaturated lipid and antioxidant protection systems providing valuable background fo further studies of biological relationships.

Studies begun

The Department of Food Science with financial support from the National Institute of Environmenta Health, has begun a long-term stud to determine whether oxidizing ai pollutants increase lipid peroxidatio and, if so, whether antioxidants wi counteract this effect.

Large stainless steel environmenta chambers have been built where rat and mice are exposed continuousl to levels of nitrogen dioxide an ozone occurring in U.S. cities o smoggy and unsmoggy days (Fig. 2) The animals are fed diets with lov normal, and high levels of antiox dants. Health and behavior of th animals are constantly observed, an biochemical changes and pathologica differences are determined afte death.

In short-term studies, rats have bee exposed to higher levels of nitroge dioxide in glass inhalation chamber The nitrogen dioxide has caused lipi peroxidation, accelerating age pi ment formation. However, high leve of biological antioxidant in the di have lowered the effects of nitroge dioxide.

It is hoped that this research pro ect will provide a better unde standing of the lipid peroxidatic induced by air pollutants, accelerate age pigment formation, and the pr tective effects of biological antiox dants.

Automated Feeding System for Dairy Cows

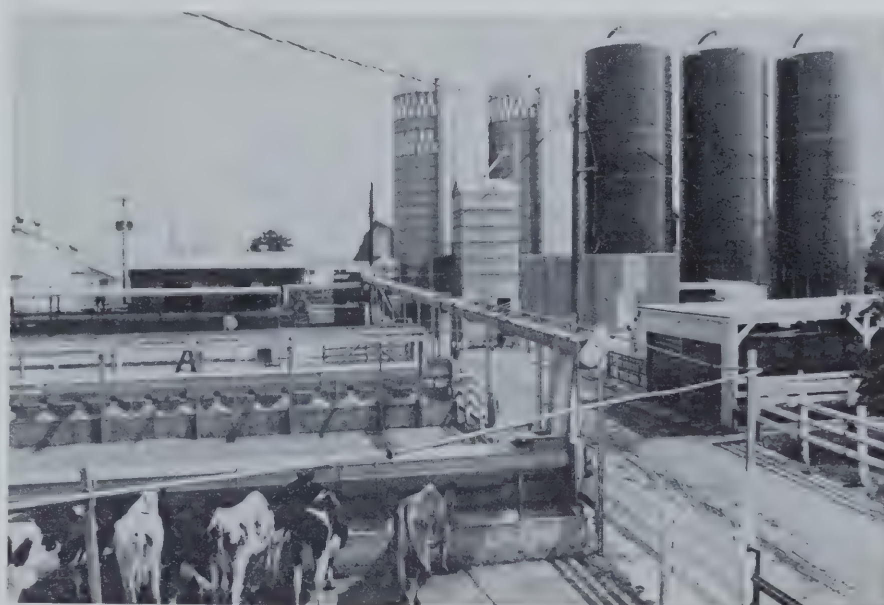
Group feeding system on the University dairy research farm mixes and dispenses rations for as many as 127 cows in five feedlots

E. F. OLVER, K. E. HARSHBARGER, G. M. HYDE, and H. B. PUCKETT

THE AMOUNT of work needed to feed a herd of dairy cows is continually being reduced at the University of Illinois dairy research farm. At present the automatic group feeding system on the farm has the capacity for automatically mixing preprogramed rations of forage and concentrate and delivering them to five feedlots that can accommodate 127 cows.

This system provides a facility for developing and testing new subsystems that will facilitate automatic operation. Automatic subsystems that have been developed at Illinois are: proportioning of forage and concentrate, resupply of concentrate bins with a pneumatic conveying system, forage flow control of top type silo unloaders, and automatic sequence feeding of several groups of cows.

In addition to automatic feeding, storage, and distribution equipment, the system features free-stall housing and complete milking facilities including a herringbone milking parlor, pipeline milking system, and a direct expansion milk-holding tank.



Dairy automation center with the five silage storage units in rear; controls and concentrate-processing center in front of the storage units; milking parlor receiving shed on right; and cattle feeders on left. (Fig. 1)

Beginning of system

When the system was first begun in the summer of 1959, pilot equipment was used to deliver a ration of forage and concentrate to a group of heifers and dry cows. The ration was 75 percent chopped hay and 25 percent concentrates made up of shelled corn, oats, and soybean meal.

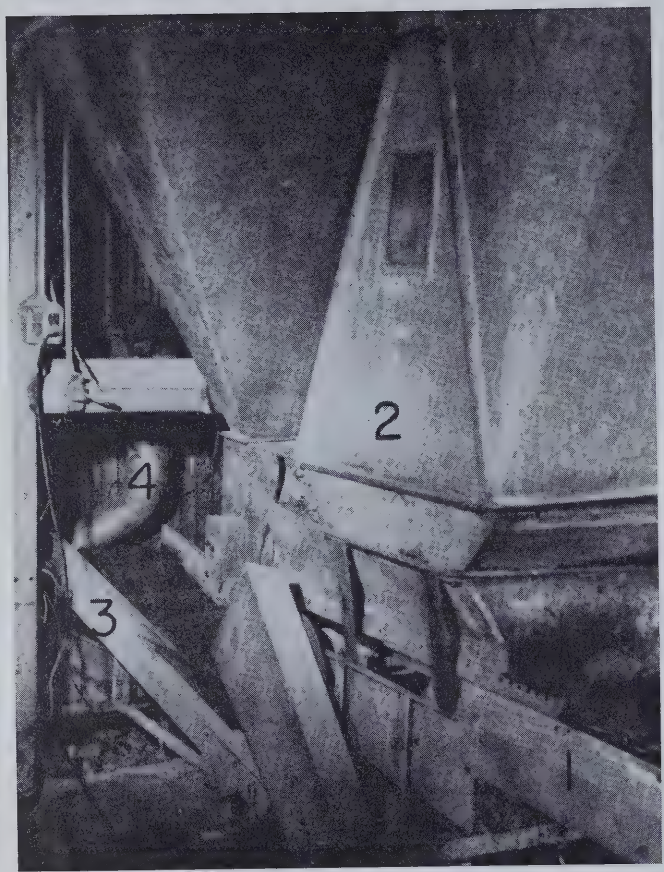
Although the equipment and controls were crude, results of the feeding trials indicated that feeding systems could be developed to satisfactorily handle forages and concentrates. Previous work had shown that self-feeding could be accomplished by grouping cows according to milk production level. From these meager beginnings was developed the present large dairy production center with its sophisticated equipment.

How the system works

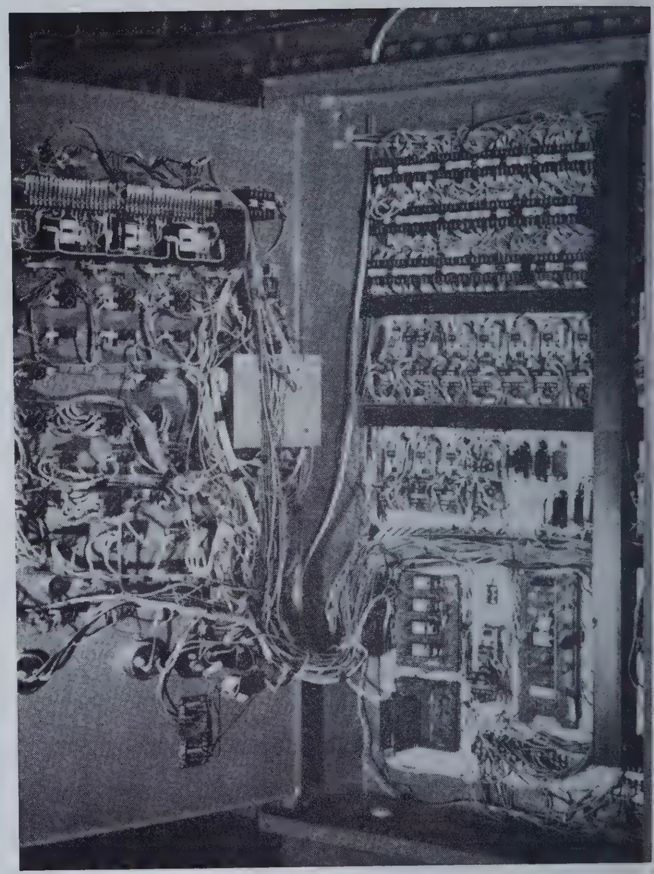
The heart of the system is the control panel that monitors the preparation of five different grain-forage rations to five different feedlots. Cows can be arranged into maximum groups of 27, 36, 20, 20, and 24 according to their production, with each group receiving a specific ration. The objectives are to eliminate individual attention in feeding and to increase accuracy as much as possible.

The feed-processing center includes five silage storage units, a four-bin grain storage and dispensing facility with an automatic hammer mill, a pneumatic conveying system for the ground grain, and a building to house the control panel and conveying equipment. One worker can regulate the rations for the 127 cattle by selecting either corn silage, alfalfa haylage, or both, plus a pre-mix concentrate mixture containing up to four ingredients. Feed can be delivered to each production group of cattle, according to its needs, as often as every 2 hours or as seldom as every 24 hours, in the quantity specifically programed by the worker for each bunk.

E. F. Olver is Professor of Agricultural Engineering; K. E. Harshbarger, Professor of Nutrition, Dairy Science Department; G. M. Hyde, Agricultural Engineer, and H. B. Puckett, Investigation Leader, Farm Electrification Research Branch, USDA.



Forage and concentrate proportioning system: (1) forage supply conveyor; (2) silo chute; (3) forage weighing conveyor; and (4) concentrate dispenser. (Fig. 2)



The main control panel, which monitors the preparation of fiv different grain-forage rations to five feedlots, is the heart of th automated feeding system. (Fig. 3

Forages are collected from the five storage structures, consisting of two top-unloaded silos and three bottom-unloaded units, by a 16-inch wide belt conveyor. They are conveyed to the forage weigher, weighed, and dropped onto the inclined conveyor. At this point the concentrate mixture is dropped onto the forage in proportion to the amount of forage moving through the system. The ratio of forage to concentrate can be adjusted from one-to-one to eleven-to-one by weight. The proportioning of the forage and concentrate is done automatically with an electronic control system which uses the forage flow signal from the forage weigher to control the output of the concentrate dispenser. The complete ration is dropped from the inclined conveyor into the overhead 10-inch horizontal auger conveyor, which delivers it to the feed bunks. The feed is distributed in the feed bunk by a double-auger type feeder that provides uniform feed distribution along each bunk.

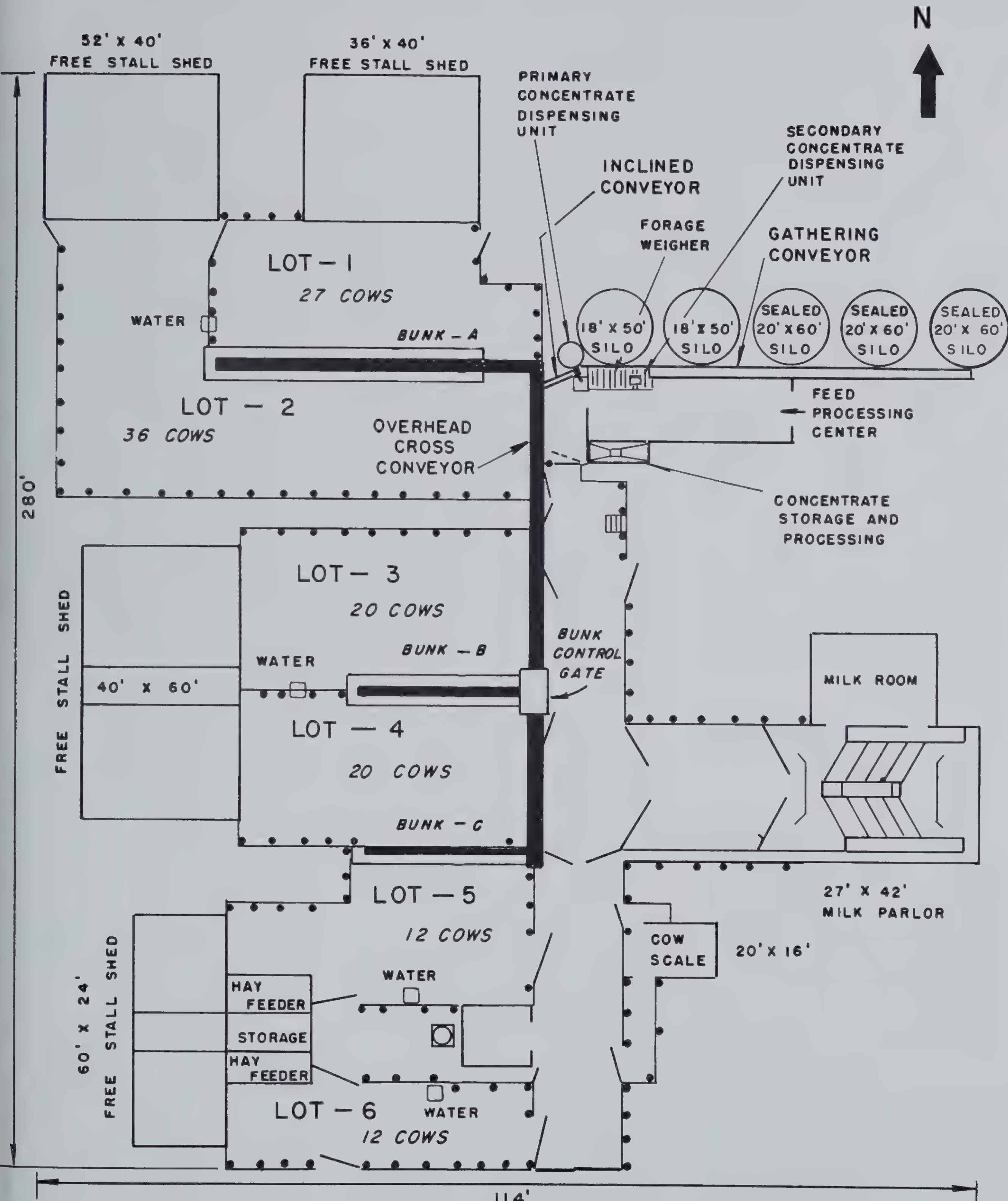
Earlier, a system was developed to control the lowering of a cable-supported silo unloader so that output would be regulated at a uniform rate. Time clocks were used to control the total amount fed to each group. In the present system, the forage weigher is used to control the total feed delivered. This is more accurate than the time clock system. Each lot has a forage weight counter that registers once for each 10 pounds delivered. When this counter reaches a preset value, the silo unloader is stopped automatically and all materials are then cleared from the conveyor in preparation for feeding the next lot.

The first four lots are automatically fed in sequence with no need for an operator except to program the proper amount of ingredients and push the start button. The fift lot is fed by resetting the controls fc lot four. The control panel can b preprogramed to select forage fror any of the forage storages for eac lot.

The concentrate mixture can b prepared from four grains propoi tioned through a commercial hamme mill. The output is pneumaticall conveyed to any of several locatior through a 1-inch conduit. This pneu matic unit was developed at th University several years ago and int grated into the feeding system.

A cooperative project

This automatic group feeding sy tem is the result of an interdisc plinary research program which h successfully combined the efforts the Departments of Dairy Scien and Agricultural Engineering and th U.S. Department of Agriculture ov an extended period of time.



Layout for the dairy automation center. Lots 5 and 6 may be combined into one lot accommodating 24 cows, as is now being done. (Fig. 4)

ENVIRONMENTAL QUALITY As Viewed by Farm and City Residents

J. C. VAN ES and CAROL KRONUS

At first the environmental crisis was seen primarily as an urban and industrial phenomenon. More recently, however, agriculture has been accused of contributing to the problem through the use of pesticides, addition of "nonorganic" supplements to animal feeds, and heavy applications of nitrogen and other fertilizers.

The controversy over the high nitrogen levels in Lake Decatur, due to nitrogen runoff from cornfields, provided the impetus to study responses of urban and rural people to environmental quality. Telephone interviews were conducted with 100 Macon County farm operators and 200 Decatur residents, all randomly selected. About half of the Decatur sample were women; half, men.

Questions covered four general areas: knowledge, evaluation of the seriousness of pollution, the individual's own pollution-abatement practices, and attitudes toward pollution control.

Knowledge

Four questions were asked to tap the respondents' knowledge of pollution issues related to agriculture. The questions were not so specific that only farmers would be expected to know the answers. But even so, the farmers were better informed than the urban residents (Table 1).

That farmers know more about a topic that directly affects their livelihood than do city people was expected. What was not expected was that only 16 percent of the farmers knew about the proposed fertilizer regulations. This percentage is surprisingly low, for farm organizations and commercial interests had worked hard to inform farmers about the Illinois Pollution Control Board's plans to regulate the use of nitrogen fertilizer.

Also surprising is that only about a third of both the farm and urban residents identified agriculture as the main source of nitrogen pollution in Lake Decatur. Whatever impact the publicity about nitrates in the lake may have had, it has not made the public well-informed about the sources of the problem.

J. C. van Es is Assistant Professor of Agricultural Economics and of Sociology; Carol Kronus, Assistant Professor of Sociology. The research reported in this article was part of a project on Nitrogen as an Environmental Quality Factor, supported by the Agricultural Experiment Station and the Rockefeller Foundation.

Table 1. — Percent of Farm and Urban Respondents With Correct Knowledge of Agriculture-Related Pollution Issues[a]

Question	Farm	Urban
Who is most affected by too high levels of nitrogen in drinking water? (Infants)	86	67
Do you agree with the statement that there is no evidence that farm practices cause water pollution? (Disagree)	62	57
Which is the main source regarding nitrogen in Lake Decatur? (Farm fertilizer)	30	35
Do you know about any current or proposed state regulations covering nitrogen pollution in water? (Yes)	16	6

[a] Correct answers are given in parentheses after each item.

Table 2. — Percent of Respondents Stating That National and Local Money Should Be Spent on Fighting Pollution Rather Than the Problems Listed

Other problems	National priorities		Local priorities	
	Farm	Urban	Farm	Urban
Fighting crime	3	17	17	26
Fighting cancer	5	24	11	31
Creating jobs	31	34	31	33
Improving education	32	35	32	28
Supporting farmers	36	71	34	67
Providing recreational facilities	77	80	64	79

Evaluation of seriousness

Respondents were asked if tax money should be spent on fighting pollution rather than on six other activities of social importance (Table 2). The majority of all respondents considered that fighting pollution was more urgent than providing recreational facilities, but less urgent than creating jobs, fighting crime, fighting cancer, and improving education. Within this broad consensus, a larger minority of urban than of rural residents would spend tax dollars on pollution control rather than on the above-mentioned items.

When it came to farm supports, farmers and city people sharply disagreed. While two-thirds of the farmers thought that farm support should have priority over fighting pollution, only one-third of the urban residents responded that way.

Asked if they agreed with the statement that ecologists have exaggerated the dangers of pollution, 65 percent of the farmers, but only 39 percent of the urban residents, concurred. Thus, the urban residents felt a greater sense of urgency about pollution problems, or at least a greater willingness to accept the judgments of ecologists.

Farm and city people also differed in their attitudes toward specific types of pollution. The respondents were asked to rate the seriousness of five kinds of pollution in the area where they lived. Decatur residents expressed more concern than farmers about industrial odors, car exhaust, nitrogen pollution, and sewage, but less concern about litter (Table 3). Although pollution may not be entirely an urban phenomenon, city people evidently worry about it more than farm people.

Since the question concerned pollution "where you live," we find support for the sometimes expressed

Table 3. — Percent of Respondents Considering Various Types of Pollution "Very Serious" or "Somewhat of a Problem"

Type of pollution	Farm	Urban
Litter — cans, bottles, paper	57	48
Industrial odors	19	66
Sewage disposal	18	24
Nitrogen water pollution	16	48
Car and truck exhaust	9	53

opinion that farmers believe pollution to be not really their problem but an urban problem. And, in reality, most forms of pollution are not easily observed in rural areas. However, this localist perspective may have serious consequences where rural behavior creates an urban pollution problem or vice versa.

Pollution-abatement behavior

Five practices that are supposed to help improve the environment are listed in Table 4, together with the percentage of respondents engaging in each practice.

About three-fourths of both farm and city residents used low-phosphate detergents, but returnable bottles were more popular among the farmers. The biggest difference between the two groups was in the percentages that refrained from burning leaves and rubbish. This difference was no doubt largely due to the availability of garbage collection and the ban on burning trash in Decatur.

Table 4. — Percent of Households Reporting the Use of Pollution-Abatement Practices

Practices	Farm	Urban
Use low-phosphate detergent	71	74
Use returnable bottles	62	48
Do not burn rubbish and leaves	29	92
Save newspapers for recycling	15	23
Buy nonleaded gasoline	11	18

Table 5. — Percent of Respondents Favoring Specific Governmental Regulations to Fight Pollution

Proposed regulation	Farm	Urban
Once an adequate lead-free gasoline is produced, people should be forced to use it	54	55
Non-returnable bottles should be prohibited	68	61
Smoking in public places (such as buses and waiting rooms) should be outlawed	69	65

Compliance with the ban against burning does not in itself indicate a strong desire to fight pollution. However, in the short run, the environmentalist will be concerned that the proper behavior takes place, regardless of motivation. In the long run, it is equally important to develop the proper motivation for combating pollution.

Attitudes toward pollution control

No matter how many pollution-control regulations may be developed, they will not be effective unless the majority of citizens agree with them. We therefore investigated the respondents' attitudes toward three issues: acceptance of governmental regulations, willingness to accept economic hardship due to pollution-control efforts, and specific attitudes relating to farming as it would be affected by pollution concerns.

A fundamental issue in pollution control is that of government regulations vs. individual responsibility. As seen in Table 5, about two-thirds of the respondents would accept government regulation of three types of behavior. Those who would not favor control may have had a variety of reasons for objecting to each item. Thus, not all would necessarily oppose government regulations on principle. In this context, the high compliance with the ban against burning trash in Decatur would indicate willingness to accept government regulation of pollution problems.

Possible economic hardships due to pollution-control measures represent another fundamental issue. Responses to the first two items in Table 6 indicate that about 60 percent of the respondents would accept certain economic hardships to improve the environment. However, these items do not state that the respondent would be directly affected. Support for a tax on leaded gasoline, which would directly affect more respondents, was

Table 6. — Percent of Respondents Agreeing With Need to Impose Certain Economic Hardships to Fight Pollution

Type of economic hardship	Farm	Urban
A company should be forced to stop pollution even if that may lead to some loss of jobs for the community	59	61
Pollution is important enough that we should be willing to pay higher taxes to fight it	59	67
Leaded gasoline should be taxed to make it more expensive than non-leaded gasoline	31	35

Table 7. — Percent of Respondents Agreeing With Farm-Related Opinion Items

Opinion	Farm	Urban
Most farmers would *voluntarily* stop certain farming methods if experts found that those practices contribute to pollution	73	50
Farm practices which contribute to pollution should be forbidden	54	70
We should not interfere with agriculture's ability to produce cheap food, even if that causes some pollution	36	25
Farmers should not have to pay for the cost of stopping farm pollution	36	23

considerably less than for the other two proposals. Apparently, many respondents are more willing to accept economic hardships for society at large than for themselves personally.

Farm and urban people differed sharply in their attitudes toward farming and pollution (Table 7). Urban residents are more doubtful than farmers about the farmers' sense of responsibility (item 1), and are more willing to prohibit specific farm practices that lead to pollution (item 2). It is apparently easier to accept the control of others' behavior than of one's own.

The future environment will no doubt reflect the influence of those who point out the impact of our style of life on the environment. But the specific shape of environmental control will equally reflect the capacity of various groups to protect their interests and shift the burden of environmental improvement to other people's shoulders.

How a Dam May Affect the Environment

Under the Oakley-Sangamon Environmental Research Program, scientists from several disciplines are seeking the answers to many questions about future ecological effects of reservoir dams

DAVID T. BELL

WHAT WILL HAPPEN to the flood plain forest ecosystem if the natural flooding pattern of a river is altered by construction of a dam? What can be done to maintain the quality of the flood plain environment? Will its aesthetic appeal be destroyed by the dam?

These questions are but a few of the many environmental considerations that are frequently ignored in determining the feasibility of impoundment projects. All too often progress is measured only in terms of economic success and increased productivity, and a cost-benefit ratio is the single criterion for determining the fate of a proposed construction project. However, when the survival of living organisms and the aesthetics of a natural habitat are at stake, cost often becomes an unrealistic variable.

With our current skyrocketing population problems, it is becoming all too obvious that the goals of maintaining modern living standards will clash more and more frequently with those of maintaining quality in our environment. Management systems must be developed that maintain both high production and high environmental quality. To do this, accurate information about all facets of the problem is essential.

Historically, efforts to increase production have received vastly more attention than efforts to measure the damaging effects of modern society on our water, land, and air. As a result, we have almost no information about the effect of dams and similar structures on the ecology of a given habitat.

Conjecture and supposition cannot take the place of established ecological fact. If we are to objectively determine the feasibility of long-range environmental consequences, knowledge about the ecological changes to be expected must receive attention.

A multidisciplinary program

In continuing the College of Agriculture's new emphasis on research concerning environmental quality and human interaction, the Agricultural Experiment Station, through its Council on Environmental Quality, has initiated a multidisciplinary ecological research program relating to the proposed development of the Oakley dam and reservoir on the Sangamon River northeast of Decatur. This research proposal has been developed jointly with, and is supported by, the U.S. Corps of Engineers and the Illinois State Division of Waterways. (The project is known officially as the Oakley-Sangamon Environmental Research Program.)

W. R. Boggess, chairman, and R. J. Miller, administrative coordinator of the Council on Environmental Quality, have directed the program from its inception. W. R. Horsfall, professor of entomology, and L. L. Getz, professor of zoology, are supervising the study of the ecology of animal populations in the flood plain ecosys-

Bottomland forests along the Sangamon River in Allerton Park during a period of low water in midwinter. Flooding is common in such habitats. What will happen to the plants and animals in this environment if flooding is increased is of major interest to the Oakley-Sangamon Environmental Research Program. (Fig. 1)

David T. Bell is Forester, Department of Forestry.

em. I have the reponsibility for co-
ırdinating the plant and environ-
nental research.

Members of the Council's interde-
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ommittee will provide added exper-
ise and guidance. This committee in-
ludes representatives from several
lepartments of the University, from
he State Surveys, and from several
tate and federal agencies.

Objectives of the program are to
letermine the ecological conditions
nd processes before, during, and
fter construction of the Oakley dam
nd reservoir and to develop methods
nd guidelines for predicting the ef-
ects that other developments con-
tructed under similar conditions may
ave on the environment. The pro-
ram will provide badly needed infor-
ıation about the interrelationships of
nvironment, vegetation, and animal
fe in stream-side natural areas.

cosystem analysis

To understand the effects of im-
ounded water on the ecology of the
angamon River flood plain and
djacent forests, it is first imperative
ıat natural conditions be monitored.
tudy sites will be established in three
inds of location: areas expected to
e inundated by the proposed Oakley
eservoir conservation pool; areas in
ıe zone of changed flooding pattern
oove the lake; and areas completely
ıtside the influence of dam im-
oundment.

The biological relationships in each
udy area will be carefully docu-
ıented. Plant and animal popula-
ons are to be extensively inventoried.
he tree vegetation at each site will
e permanently marked and mapped
r continual reference. Species, di-
neter, height, crown characteristics,
ıd vigor of each tree will be re-
ırded. Information on herbaceous
ıd shrub vegetation for each area
ill be correlated with the tree study.

Populations of small mammals in-
ıbiting the flood plain and adjacent
plands will be monitored to observe
ıanges in behavior patterns or pop-
ation dynamics caused by flood
ain inundation under normal flood-
g patterns and later under the altered patterns resulting from the dam water impoundment. The effects of flooding on the population dynamics and species distribution of several selected invertebrates inhabiting the surface litter and soil of the flood plain will also be studied. Mosquito species will be observed to obtain data on the behavior of insect groups during flooding. Special emphasis will be placed on species that lay eggs on the flood plain and those that lay eggs on the water, so that we can determine the effects of the proposed flooding regimes on these two groups of mosquitoes.

Characteristics of the environment, including solar radiation, precipitation, temperature, and relative humidity, are monitored with standard weather instruments. The weather stations are on towers to protect the instruments from flood waters. (Fig. 2)

Aspects of the physical environment will also be carefully documented. Micrometeorological stations at the study sites will provide detailed data on precipitation, temperature, relative humidity, and solar radiation. These figures will be supplemented by information from state and federal agencies. Hydrological data will be gathered at stream-gaging stations and piezometers drilled into the flood plain within the study areas. Siltation and erosion resulting from the changing flood patterns will also be observed. In addition, information on the water quality of the Sangamon River and Lake Decatur will supplement the information that the State Water Survey has already gained on the nutrient levels of the water in this region.

All data, both biological and physical, will be computer-correlated to establish the relationship between existing plant and animal populations and the environment of the flood plain under natural conditions. This will establish the foundation of knowledge necessary to continue the research program if the Oakley Reservoir is constructed.

Correlations between the biological and physical factors in the flood plain ecosystem can be very helpful in predicting the post-project ecosystem. Unfortunately some correlations can sometimes be misinterpreted as being cause-and-effect relationships. The correlations established by our research program will provide a much better estimate of what will happen to the ecosystems of riparian flood plains after the construction of reservoir dams.

THE LABORATORY ANIMAL:

An Important Biological Tool That Must Receive Careful Treatment

W. M. NEWTON

ALEXANDER POPE once wrote, "The proper study of mankind is man." Had his dictum been rigidly followed, however, we would be without most of the biomedical advances that have contributed to the way of life we enjoy today.

To study man — his diseases, biology, and behavior — certain conditions must often be simulated in laboratory animals. The laboratory animal is the most intricate and delicate instrument used by biomedical and biological scientists. For valid experimental results, animals must be of high, uniform quality, and receive meticulous care in a controlled environment. Humane treatment is also imperative.

In recent years laws have been passed and policies formulated dealing with the care, handling, and treatment of warm-blooded experimental animals. Birds and such domestic species as horses, cattle, and sheep are currently excluded from coverage by the new laws and policies. Also excluded are amphibia and other cold-blooded species, which are often used in important experiments. These species are therefore omitted from the following discussion.

Quality animals are essential

The more sophisticated the biomedical experimentation, the greater the need for well-defined experimental animals. Just as clean glassware is crucial to the analytical chemist, quality animals are necessary to the research biologist. Many an experiment has gone awry because the wrong animal model was used or because the experimental animal became sick or died.

Two major technological advances have made it possible to produce and maintain defined, quality animals: (1) The technology is available to develop inbred strains in many species, and (2) germfree technology can be adapted to the production of pathogen-free mice, rats, and other animals.

The use of germfree technology has been the most successful method of eliminating disease in laboratory animals. Many other methods, including vaccination and medication, have been tried with less success. Unless animals are pathogen-free, they carry a variety of disease-producing organisms. Even when these organisms don't cause disease, they lurk as a constant threat to the animal and consequently to whatever experiment is under way.

Unfortunately, even though the knowledge is available to produce germfree animals, as well as inbred strains, limited facilities and programs have restricted the use of these defined animals.

In 1960, about 50 percent of the research animals in nonprofit, nongovernmental institutions could not meet the minimal standards for high-quality scientific studies. This conclusion resulted from a survey conducted by the Institute of Laboratory Animal Resources, National Academy of Sciences-National Research Council, under the sponsorship of the National Institutes of Health.

In a 1968 survey, the same organization found that over 25 perce[nt] of the animal facility space in u[se] needed renovation. The survey al[so] showed that the existing space need[ed] to be increased by 50 percent to ove[r]come crowded conditions. The repo[rt] of the survey included recommend[a]tions that about 190 million doll[ars] be spent over a five-year period [to] create animal facilities that wou[ld] adequately support biomedic[al] research.

New legislation and policies

In response to a nationwide co[n]cern for the welfare of animals us[ed] in research, federal legislation w[as] passed in 1966 to control the ca[re,] handling, treatment, and transpor[ta]tion of laboratory animals by deal[ers] and research institutions. The le[g]islation applied to dogs, cats, ha[m]sters, guinea pigs, rabbits, and no[n]human primates. The standar[ds] imposed by the legislation are gen[er]ally considered minimal, in that th[ey] deal with the basic essentials of fe[ed]ing, watering, sanitation, cage si[ze,] and animal health. To assure th[at] the standards in no way interfe[re] with the scientific program, anim[als] actually in research projects w[ere] excluded from coverage.

The Animal Welfare Act of 1[9..] amended the 1966 law to cover v[ir]tually every type of warm-bloo[ded] animal, including animals in circu[ses,] carnivals, and zoos. The new law a[lso] requires that the standards be app[lied] to animals actually on research. [It] has been estimated that this amen[ded] law will triple the number of anim[als] coming under federal surveillan[ce.] However, rats, mice, birds, and ...

W. M. Newton, Associate Professor of Veterinary Physiology and Pharmacology, is Director of the Office of Laboratory Animal Care.

ain domestic species have been temorarily excluded from coverage beause of a shortage of surveillance fficers. We can anticipate that these nimals will come under surveillance s soon as the number of officers can e increased. The new law includes section on the appropriate utilizaon of anesthetics, tranquilizers, and nalgesic drugs.

In 1971 the National Institutes of Iealth of the Department of Health, ducation, and Welfare published a ew policy on the care and treatment f animals used in projects supported y NIH funds. This policy places the esponsibility directly upon the reearch institution to care for laboraory animals as prescribed in the *'uide For Laboratory Animal Facilies and Care.* The guide was preared through the auspices of the nstitute of Laboratory Animal Reources, National Academy of Scices. In contrast to the legislative andards, which are minimal, the ecommendations in the guide are otimal standards, essential for the aintenance of quality animals.

ampus advisory groups

To comply with the National Initutes of Health policy, the condions under which experimental anials are maintained may be evaluated ther by the American Association r the Accreditation of Laboratory nimal Care or by an institutional aluation committee.

Since the animal facilities on the rbana-Champaign campus of the niversity of Illinois do not qualify r accreditation by AAALAC, the aboratory Animal Care Advisory ommittee, first established in 1967, s been designated as the evaluation mmittee. This committee, which is pointed by the Dean of the Gradue College, is made up of representaes from the academic units that e animals. Results of the commite's evaluation are to be reported nually to the director of the Nanal Institutes of Health.

The Office of Laboratory Animal re was also established on the bana-Champaign campus in 1967. ie purpose of this office is to assure compliance with the laboratory animal welfare legislation and to generally upgrade the level of animal care in the many animal facilities dispersed around the campus.

Campus facilities and needs

Sixteen departments in four colleges use a total of almost 60.000 experimental animals a year for teaching and research programs. On any given day, about 15,000 animals are housed in more than 20 facilities.

A survey by the Office of Laboratory Animal Care in 1967 revealed that the animal resources on the campus needed considerable improvement to provide the quality animals necessary for complex research. Since the law stipulated that cage size be increased, it was evident that more animal space was also needed.

A research animal holding facility that would serve campus needs was proposed and has been requested in every capital budget since 1969, but each year the proposed building is deferred. The need for the facility is becoming more critical as new legislation and policies extend coverage to additional species.

In addition to adequate facilities, a good program must provide for the day-to-day care of the animals, the purchase of animals and supplies, the sanitation of cages, the maintenance of equipment, the training of personnel, and the administration and accounting associated with the program. Disease diagnosis and control are also essential.

Commercial organizations or testing laboratories that require good research animals are usually serviced by a centralized animal care program. In colleges and universities, separate animal care programs have usually developed in each department using laboratory animals. There is much to be said for the independence provided by departmentalized programs, yet the standards of care may be variable. Centralized programs, even in dispersed facilities, offer a standard level of care and more efficient use of personnel, space, and funds.

With the advent of legislation and policies imposing outside influence on animal care, and with a greater concern for budget frugality, the trend in academic institutions is toward centralized programs. It is recognized that there may be special cases where the research requirements cannot be adequately met by a centralized program, but barring these few exceptions, a centralized program has far more advantages than a decentralized one.

The emphasis on strong, centralized programs of animal care was apparent in a recent announcement by the Animal Resources Branch of the National Institutes of Health that limited funds are available for projects to improve *institutional* animal resources. Specifically, the projects are to help institutions comply with the animal welfare legislation and the National Institutes of Health policy. Applications for support are to be reviewed on the basis of need and the project's capability to bring the institutional animal research resources to a suitable level within a three-year period. At present, the Office of Laboratory Animal Care is awaiting review of its application for project support of about $225,000.

Many advances are yet to be made in biomedical science that will contribute to the health and well-being of man and animals alike. Most of these advances can come only through the use of animal models in crucial experiments. It should be the concern of all that appropriate animal models are maintained under controlled environmental conditions to assure defined research tools for scientific discoveries.

Some progress has been made at the Urbana-Champaign campus, but there is much to be done before all scientists can be assured of quality animals. The most expedient and economical way of insuring such animals is to construct a campus animal resource facility. This would not only provide the quality animals needed for sophisticated studies but would also remove the threat of losing large sums of research dollars for failure to comply with the required standards for animal care.

Blood Serum Composition Of Parturient Dairy Cows After Calcium Injections

K. A. KENDALL, K. E. HARSHBARGER, R. L. HAYS, E. E. ORMISTON, and S. L. SPAHR

The blood composition of dairy cows has long been known to change during the last week before calving and the first 24 to 48 hours afterward. Serum calcium levels often decline from 10 or 11 milligrams per 100 milliliters (mg%) to around 8 mg%; inorganic phosphorus concentrations, from a normal of 4 or 5 mg% to around 3 mg%. The sharpest declines in calcium and phosphorus are often accompanied by an increase in blood reducing sugar. This increase, which lasts for only a limited time, usually occurs within a few hours after calving. Two or three days later, blood composition ordinarily returns to normal.

At the third calving and beyond, serum calcium and phosphorus levels may sink so low that parturient paresis (milk fever) develops. Calcium levels may decline to 4 mg% or lower; phosphorus concentrations, to 1 mg%. Blood sugar levels may reach 100 mg% or more. The cow is unable to stand and has the usual symptoms of tetany, muscle tremors, somewhat lowered body temperature, and weak or no apparent rumen activity.

At this point, the clinician usually administers an intravenous (IV) injection or occasionally an intraperitoneal (IP) injection of a solution containing 20 to 25 percent calcium borogluconate, with or without phosphorus or dextrose (glucose). Prompt recovery usually follows an IV infusion. Recovery is more gradual after an IP injection.

The authors are all members of the Department of Dairy Science. They gratefully acknowledge the clinical assistance and diagnostic service provided by the College of Veterinary Medicine.

Numerous cows studied

During the past several years, the blood composition of many parturient cows on the University dairy farm has been studied. We have also observed the effects of IV and IP injections on paretic cows. Because the blood composition of a parturient cow can change greatly in a few hours, venous samples are taken frequently and serum composition is determined by standard methods.

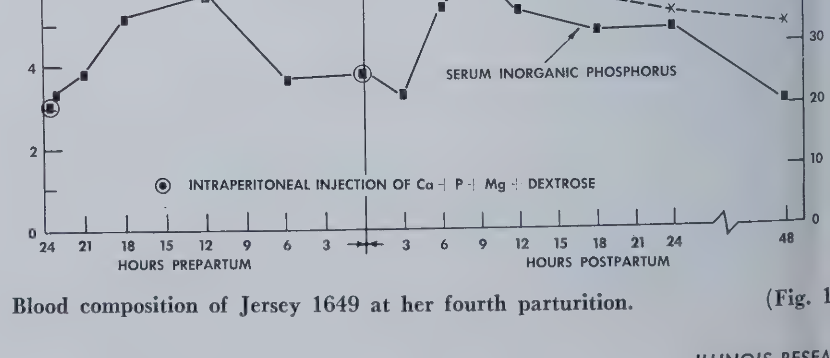
The following case studies of three parturient cows with paretic histories show the effects of IP or IV injection of preparations containing calcium. Each cow's overall condition was observed, as well as her blood composition.

Jersey 1649 received an IP injection about 24 hours before parturition, and another right after she calved. Each consisted of 900 mill liters of a solution containing 12 pe cent calcium, 4.5 percent phosphoru 2.7 percent magnesium, and 5 pe cent dextrose.

At the time of the first injection sl appeared normal and showed paretic symptoms. This judgment w later verified by the blood analys which showed the calcium level to 7.6 mg%; inorganic phosphorus, 3 mg%; and sugar, 55 mg%. By co trast, at her previous parturition s had developed parturient paresis a her serum calcium, inorganic ph phorus, and sugar levels had been 5 2.94, and 101.8 mg%, respectively.

Six hours after the first injectio calcium and phosphorus levels rose 11.3 and 5.4 mg%, respectively, clining to only 8.3 and 3.7 mg% minutes after calving (Fig. 1). At t time, the second injection was ma and calcium and phosphorus lev again rose. Maximum levels of 1 mg% for calcium and 6.7 mg% phosphorus were reached 9 to hours after injection. By 48 hou calcium and phosphorus levels w above 9.0 and 3.0 mg%, respectiv Paresis did not develop.

Inorganic phosphorus typically creased after the calcium injectio while the reducing sugar level show an inverse relationship until 9 to hours after each injection. The f



Blood composition of Jersey 1649 at her fourth parturition. (Fig. 1

:her decline in sugar level may have)een due to the calf nursing and)artial milking.

Holstein 1689 appeared normal during the first hour after calving. However, her paretic history)rompted the IP injection of 500 nilliliters of calcium gluconate (27)ercent) at that time. Her blood :tatus was found upon analysis to be uch that paresis might have devel-)ped without the injection.

As indicated by serum calcium and)hosphorus levels after the injection (Fig. 2), a paretic attack did not levelop for 12 hours postpartum. At 18 hours symptoms began to ap-)ear, and at 25 hours the syndrome vas fully developed, necessitating an V calcium injection. Not until the hird day after calving was she lefinitely on the way to recovery.

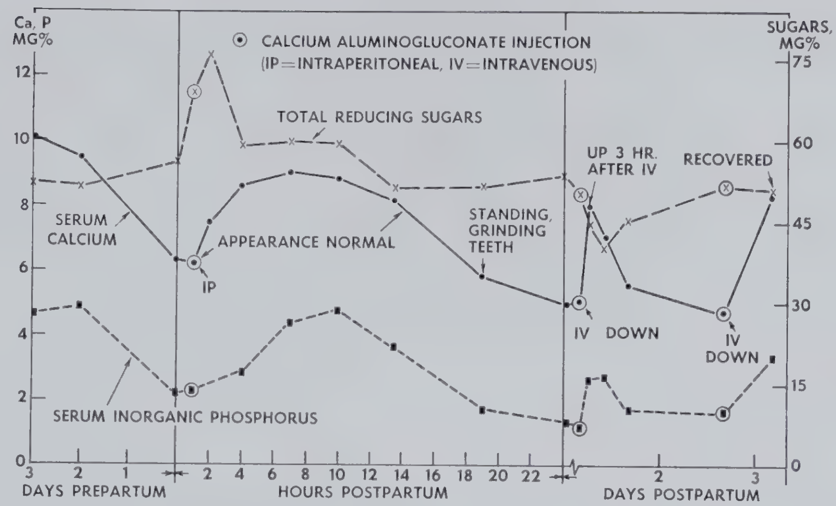
At her next calving, after an ade- juate dry-cow feeding regimen, her owest observed blood calcium was).6 mg%, and she developed no)aretic symptoms.

Ayrshire 1919, also a paretic sus-)ect, was extremely fat when she alved. Although she appeared nor- nal at that time, her serum phos-)horus and calcium levels were low vhile the sugar level, at 187 mg%, vas excessively high (Fig. 3).

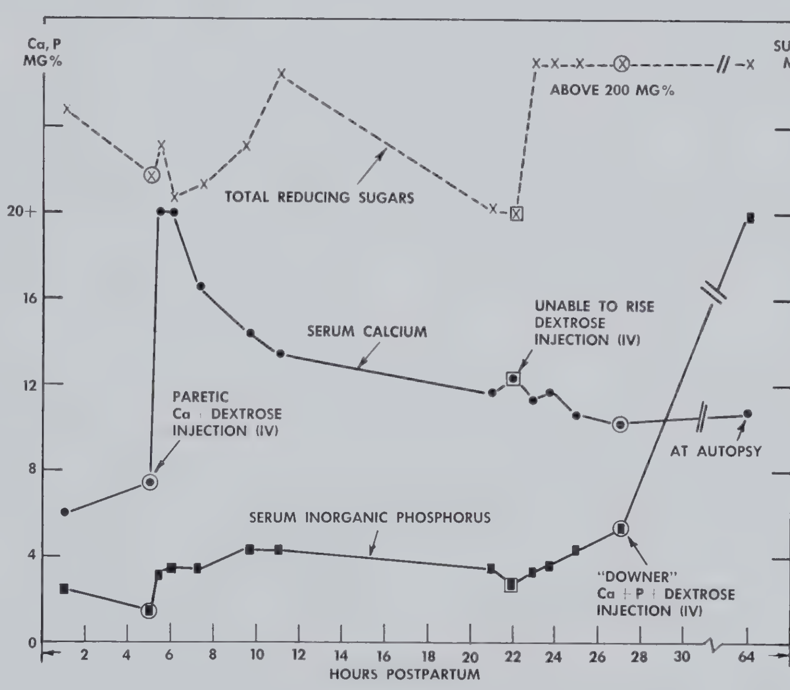
Five hours after calving, when she eveloped paretic symptoms, 500 mil- liters of a solution containing cal- ium gluconate and dextrose was ad- ninistered IV. Within 30 minutes, ne calcium level rose from 7.4 to 0.0 mg%; the phosphorus level, om 1.46 to 3.28 mg%. However, igar levels also increased and she lowed no sign of recovery.

At 22 hours postpartum, she was iven 1 liter of 50 percent dextrose. It 'as not known until after the blood nalysis that blood sugar level at the me of the injection was 150 mg%. nmediately after the injection, blood igar rose above 200 mg% and re- nained there until the cow's death 64 ours after calving. At 27 hours post- artum a calcium gluconate solution ith phosphorus and dextrose had een administered, but had not re- ved the "downer cow" condition.

Final blood constituent levels were determined from blood taken from the heart at autopsy. The autopsy revealed an enlarged and very fatty liver, acute metritis, acute mastitis, and extensive kidney degeneration.



Blood composition of Holstein 1689 at her fifth parturition. (Fig. 2)



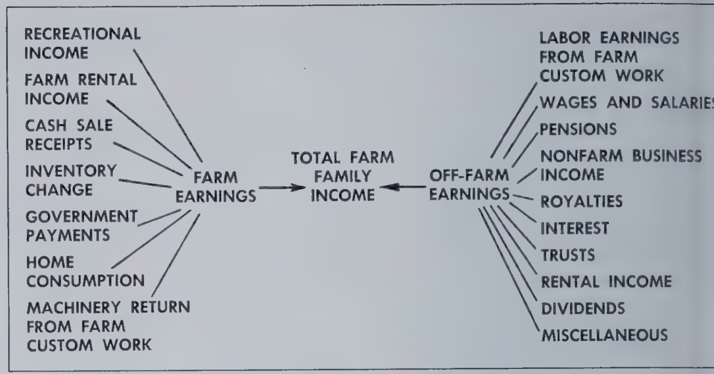
Blood composition of Ayrshire 1919 at her fifth parturition. (Fig. 3)

Calcium gluconate effective

It is apparent in two of these case studies that IP administration of calcium gluconate resulted in a gradual increase of serum calcium. This was accompanied by a rise in serum inorganic phosphorus, even when phosphorus was not included in the injection. Normal to near-normal levels of both calcium and phosphorus were maintained for at least 14 hours after parturition, and paresis was either prevented or delayed.

The observation of Ayrshire 1919 suggests that phosphorus and dextrose may not be necessary in treating paretic cows, especially since their blood sugar is frequently above normal. This is a question that merits further study.

More Farm Operators Are Supplementing Their Income With Off-Farm Earnings



Sources of the total farm family income.

R. G. F. SPITZE and R. J. HANSON

INCOME is a topic touching every person in Illinois agriculture. It is one of the prime economic goals of all investment, employment, and production, and a subject of public agricultural research.

In a commercial economy, efficient production enhances the public welfare only as it is translated through the income stream into consumer purchases or savings. Yet complete and reliable information about the income stream in the farming sector is often not available for public decision makers.

Meaning of income

Confusion exists not only about the level of income but also about the very concept of income. Net income, sometimes confused with total or gross payments, is defined as the market return to the factors of production (land, labor, management, and capital) for their economic contributions to production. That is, individuals or corporations receive the appropriate returns for whatever factors they control. Most farmers operate as individual proprietors or partners, and hence will receive an income stream for their labor and management plus whatever land or other capital they own.

It is precisely this embodiment of the laborer, manager, and capitalist into one person that makes it so difficult to determine farm income. Furthermore, the farm business usually provides the farmer with a home. Adjustments must be made for this value, usually not a part of net cash income, if the farmer's estimated income is to be comparable to that of the nonfarmer who pays for his dwelling out of net cash earnings. Home consumption of farm products poses a similar problem, but has rapidly diminished with specialized farming.

R. G. F. Spitze is Professor and R. J. Hanson, Research Assistant, Department of Agricultural Economics.

Finally, the farm income picture is clouded by two situations. One is that the Census term "farm" includes all units of roughly 10 acres or more if some products are sold. Thus, it encompasses many small farms run by part-time operators, whose main source of income is off-farm work.

The second situation arises from the advances in technology that have increased the optimum size of a farm. Many of the farm families who are not quitting farming entirely are having to supplement their incomes with off-farm work. According to the U.S. Census of Agriculture, the number of farms in Illinois has *decreased* by 35 percent over the past 20 years, while the percentage of farmers reporting off-farm work has *increased* from 3 percent to 50 percent.

Table 1. — Per Capita Personal Income of U.S. Farm Population, Selected Years, 1935-70[a]

Year	Farm sources	Nonfarm sources	All sources
1935	$ 169	$ 72	$ 241
1940	158	91	249
1945	524	181	705
1950	612	272	884
1955	597	325	922
1960	737	458	1,195
1965	1,096	812	1,908
1970	1,462	1,370	2,832

[a] USDA, *Farm Income Situation*, July, 1971.

Table 2. — Average Illinois Farm Family Income by Source and Type of Farm Operator, 1971

Income source	Type of farm operator: All farmers	High farm income[a]	Low farm income
Off-farm family income			
Wages, salaries	$3,826	$2,215	$6,07
Net nonfarm business income	467	233	79
Custom farm work	235	371	4
Interest	387	465	28
Dividends	247	290	18
Rental income	159	165	15
Royalties	12	6	2
Trusts, estates	139	212	3
Pensions, retirement benefits	157	50	30
Miscellaneous	46	62	2
Total	5,675	4,069	7,9
Net farm income	5,284	8,109	1,4
Total farm family income	10,959	12,178	9,3

[a] High farm income: $10,000 or more from gr farm sales.
[b] Low farm income: less than $10,000 from gr farm sales.

Although the off-farm earnings farm family members expand fami income flow, these earnings are n revealed in farm business return Other sources of income may also included in the total family incon flow, as shown in the above chart.

Existing farm income data

Farm income knowledge has e panded but usually refers to only o type of income or a particular se ment of farming. Analysis of farme kept records has been a prima source of income data from the fa

Pinkeye Is Studied in Calves at Dixon Springs

DALE R. MILLER, H. W. NORTON, GEORGE CMARK, M. E. MANSFIELD, A. H. KILLINGER, and F. C. HINDS

CATTLEMEN have been asking a number of questions about pinkeye. For example, is susceptibility inherited from the sire? From the dam? Does the dam's age affect the occurrence and severity of the disease? Is creep availability important? How does the severity of infection affect weight loss?

To answer some of these questions, the Department of Animal Science and the College of Veterinary Medicine recently cooperated in a study of pinkeye in weanling calves. The study was conducted at the Dixon Springs Agricultural Center.

Pinkeye is the common name for a disease that affects the eyes of cattle, sheep, and goats. Conjunctivitis and keratitis are the medical terms for this condition. It is caused by the organism *Moraxella bovis;* however, several organisms have been isolated from infected eyes.

Dale R. Miller, former Assistant in Animal Science; H. W. Norton, George Cmark, and F. C. Hinds, Department of Animal Science; M. E. Mansfield and A. H. Killinger, College of Veterinary Medicine.

How severity was measured

Pinkeye severity was determined by measuring the length of scar tissue in infected eyes. Although scar length is not perfectly representative of pinkeye severity, it is the best available measurement.

Readings were made for the calves' eyes during June-July and October; for the dams, in June-July and December. Scores of 0 through 5 were given for each eye, with 0 being normal. Scar lengths of 1 to 5 millimeters were scored 1; 6 to 10 millimeters, 2; 11 to 15 millimeters, 3; 16 to 20 millimeters, 4; and 21 to 25 millimeters, 5.

Pinkeye severity was evaluated in relation to 205-day adjusted weight by means of regression analysis (method of least squares). This method was also used to analyze the effects of sire, creep, and location on pinkeye severity and on 205-day adjusted weight.

Measurements were made on 302 calves born in the spring of 1970. Of these, 242 were included in the statistical analysis. Some calves were omitted from the analysis because complete data were not available, or because there were only one or two calves having the same sire at a specific location.

Few correlations found

Usually, if an animal was infected with pinkeye both eyes were involved. However, only a slight correlation was found between the two eyes in degree of severity.

Sires seemed to have no effect on the calves' susceptibility or resistance. The differences in scores of calves from different sires were no greater than would be expected from random sampling.

No correlations were found between calves' and dams' scores obtained in June-July. There was, however, a correlation between calves' scores obtained October 29 and dams' scores obtained December 1. This result may be due to the continued occurrence of pinkeye throughout the summer. The fall measurements would represent a summation of the

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More Farm Operators (conc.)

business. One of the best of such efforts is the University of Illinois' records on nearly 7,000 Illinois commercial farms, the results of which are published annually as the *Summary of Illinois Farm Business Records.*

Farm Income Situation, published by the U.S. Department of Agriculture, contains annual estimates of gross and net income flows from the farm business to the farmer. These estimates are given both as totals and the average per farm in each state. The estimated flow of income to the farm family from nonfarm sources is also given, but only at the national level (Table 1). This has recently been supplemented by estimates of farmers' income from farm and off-farm sources, again at the national level only, from a sample analysis of federal income tax reports. The most recently published analysis is USDA's ERS 498, 1972.

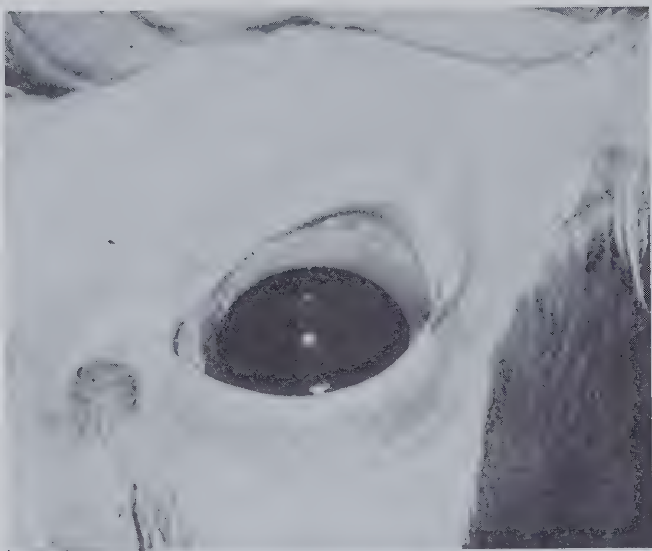
Finally, a recent study reported in ILLINOIS RESEARCH, Spring, 1970, presented farm and off-farm earnings from a selected group of commercial farmers in central Illinois.

Statewide study launched

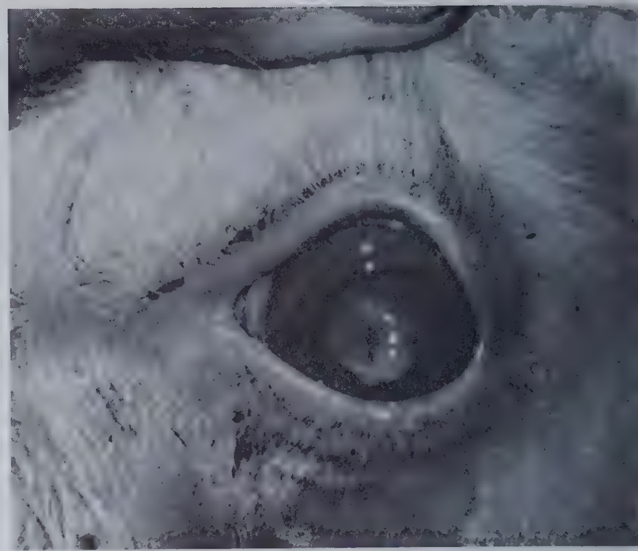
To obtain both farm and off-farm income data, particularly for lower income farmers throughout Illinois, additional research was initiated during the past year. Since the lower income group could not be identified beforehand, a carefully selected random sample of all Illinois farmers was surveyed by mail. With a questionnaire return of 35 percent, believed to be representative of the state's farmers by area and size of farm, data are now available about farm and personal characteristics, level of farm and off-farm income by source and family member, and off-farm work history.

Some data from this study are reported in Table 2. It gives average net cash income from farm and off-farm sources received in 1971 by the entire farm operator family. As would be expected, off-farm income decreased as net farm income increased. However, off-farm income remained amazingly high even among families with high farm income.

A future report in this publication will analyze the income flow for the low farm income group, personal and farm characteristics associated with income levels, and factors affecting off-farm employment.



Clear eye with early tearing. (Fig. 1)



Acute pinkeye with corneal ulcer, inflammation, excessive tear- ing, and temporary blindness. (Fig. 2

Healed pinkeye lesion with moderately severe corneal scar. Vision is impaired. (Fig. 3)

Healed pinkeye lesion with ruptured cornea. Animal is pe manently blind. (Fig.

infections following, as well as those preceding, the June-July scorings.

Sex of calf did not significantly affect scores. Neither did age of dam or the availability of creep feed. This finding thus does not support the common belief that creep availability and the dam's milk production affect the degree of infection in the calf.

Location did affect the calves' scores. Infections in calves at Smith pasture (one of the five pastures in the study) were significantly more severe than at all other locations except the Turkey Farm pasture. The adjusted two-eye total score at Smith was 3, moderately severe.

Pinkeye score (the sum for two eyes) was associated with 205-day adjusted weight. This difference was significant at the 1-percent level for June-July data and at the 5-percent level at weaning (October 29). At the summer reading, calf weight was reduced 6.8 pounds for each unit of two-eye total score. By weaning, the reduction was 5.4 pounds. One can hypothesize that the diseased calves possess the capacity for compensatory gains as a result of the infection.

What the average loss at weanin can mean to profits is illustrated b the following example: A calf has pinkeye score of 3 in each eye (seve infection), giving a total score of for the two eyes. With a weight loss 5.4 pounds for each unit of scor total weight loss would be 32 pounds. At a selling price of $40 hundredweight, the diseased ca would sell for $12.96 less than healthy calf. A severe pinkeye infe tion can thus dramatically reduce producer's capital returns if he se his calves as weanlings.

Members of a "Citizens in Action" Community 4-H Club in Rock Island County demonstrate some of their newly acquired skills in food preparation. Eleven Community 4-H Clubs in the county reached 707 young people who had not previously been 4-H members. Among the volunteer leaders were teen-agers from the Chefs Extension Club and 4-H Federation.

4-H Reaches Out to Handicapped And Disadvantaged Youngsters

GEORGE L. DAIGH and WALTER E. GRIFFITH

A SPECIAL EFFORT is being made to draw handicapped and disadvantaged boys and girls into 4-H programs.

The effort has been stimulated by grants made to counties by the Illinois 4-H Foundation. A nonprofit, educational, public corporation, the Foundation was organized in 1954 to supplement existing 4-H programs with funds contributed by private individuals and businesses.

The special grants for reaching the handicapped and disadvantaged began in 1969, when the Foundation included $2,100 for that purpose in the annual budget. Cooperative Extension Service County staffs who wanted grants were asked to submit written proposals telling how the money would be used. Proposed programs had to be in addition to the regular 4-H programs. No county would be given more than $500, or receive a grant for more than three years for the same program.

George L. Daigh and Walter E. Griffith are Assistant State 4-H Program Leaders.

In 1969 the Foundation received proposals from 17 counties with requests totaling over $9,500. A committee was appointed by the Foundation Board to choose from the proposals, primarily on the basis of three questions: Which programs would most benefit the participants? Which could be carried on without Foundation help? How much of the proposed budgets could be furnished by the counties?

That year 10 counties received grants ranging from $100 to $350. Three of the grants were for work with the handicapped and seven for work with the disadvantaged. Perhaps the most significant result of providing these funds was that they permitted the beginning steps toward a flexible 4-H program designed to attract boys and girls other than the easy-to-reach.

In 1970, five programs were funded in amounts ranging from $100 to $500. Three of the programs were for the handicapped and two for the disadvantaged.

Piatt County was given a modest $100 to work with handicapped youngsters in a day camp experience. As plans were made to use the grant and word got around the county, various county groups added $900 to the Foundation "seed" money. Naturally more youngsters could be included in the program and the program could last longer. Edgar County established a continuous 4-H program for educable mentally handicapped boys and girls as a result of the Foundation grant.

The 1971-72 Foundation budget included the $2,100 item for the county grants but a total of $2,685 was actually given out. Nine proposals, four for the handicapped and five for the disadvantaged, were funded in amounts ranging from $80 to $500. Since the funds were disbursed in December, 1971, no results will be known until the fall of 1972. The Foundation Board believes so strongly in the county grant program that $3,100 has been budgeted for this purpose in 1972-73.

So far more than 800 disadvantaged girls and boys in 17 clubs and 39 handicapped in three clubs have become 4-H members through the use of Foundation funds. Membership has brought a new dimension into the lives of these young people, giving them the opportunity to work together in a group, identify with a national youth program, learn useful, everyday skills, serve on committees, hold offices, and work with concerned adults. The true value of the program will not be known for some time, but in the eyes of the Illinois 4-H Foundation Board of Directors, it is already paying off in the increased interest among county extension staffs in carrying out 4-H work with disadvantaged and handicapped young people.

FARM BUSINESS TRENDS

FARM OPERATING COSTS are an unpleasant — even painful — subject. Yet they must be considered by every farmer who plans successfully for the future.

Farm production expenses totaled $42.9 billion in 1971, according to USDA economists. Expenses increased 59 percent in 10 years, and the average annual rate of increase was 4.7 percent.

The share of gross farm income taken by production expenses increased from 68 percent in 1961 to 73 percent in 1971.

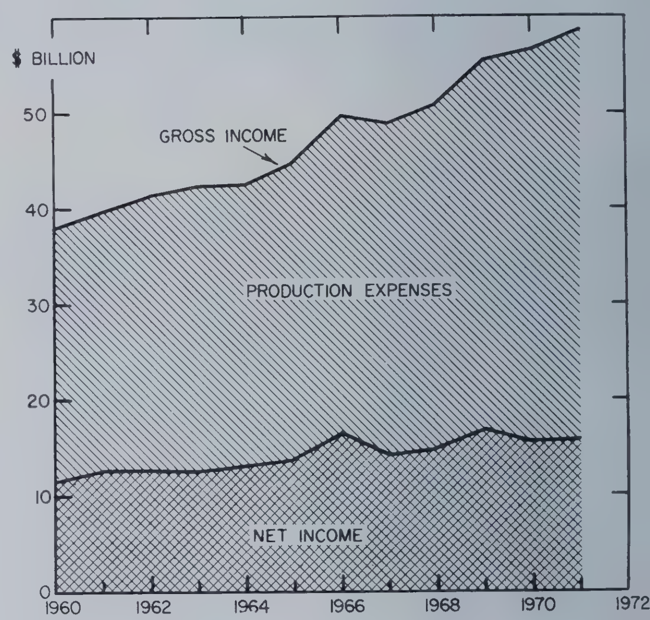
Gross farm income increased 47 percent in the decade, reaching $58.6 billion last year. During the same time realized net farm income went up 24 percent, reaching $15.7 billion in 1971.

Farm production expenses seem likely to continue their upward trend during the rest of the 1970's. Labor is the biggest cost in most of the products and services used in farming. No major industrial nation in the free world has been able to restrain labor costs in recent years. In our own country, many groups are increasing their efforts to obtain large increases in wages and salaries.

We are becoming increasingly dependent upon imports for petroleum products, and costs are headed upward. Higher prices are expected, too, for fertilizers, chemicals, and machinery. Public demands for environmental protection and improvement will also add to direct and indirect farm operating expenses.

During the past 15 years or so, most Illinois farmers have met increased costs by farming more land and increasing average yields per acre. Some farmers also received assistance from rising prices for cattle, hogs, and milk. Some future gains from these sources are likely, but they may not be enough to prevent further pressure on farm operators' profits.

While U.S. farm income increased only 24 percent from 1961 to 1971, the income of farm families from nonfarm sources nearly doubled. Then, too, the total was divided among fewer families each year. Consequently the average income per farm from all sources increased about 65 percent during the decade.



Realized gross and net farm income, and production expenses, United States, 1960-1971.

UNIVERSITY OF ILLINOIS · AGRICULTURAL EXPERIMENT STATION
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Fall, 1972

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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How fast can a little boy wear out his jeans? (See page 8.)

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

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PLANT PATHOLOGY HAS NEW HEAD

ON SEPTEMBER 1, Richard E. Ford became the second head o the Department of Plant Pathology, succeeding Wayne M Bever, who retired on August 31.

After growing up on an Iowa farm, Dr. Ford did his undergradu ate work at Iowa State University. From there he went to Cornel University as a graduate student and assistant. Upon receiving hi Ph.D. degree in 1961, he moved across the country to Corvallis Oregon, where he held a dual appointment with the USDA an Oregon State University from 1961 to 1965. In 1965 he returne to Iowa State University as associate professor (later professor) i botany and plant pathology, remaining there until he came t Illinois.

Dr. Ford has done research on a number of viruses infectin plants, especially those that attack peas and corn. His particular in terest at present is the maize dwarf mosaic virus of corn. He is sec retary of the American Phytopathological Society, besides belongin to a number of other professional organizations.

Dr. Bever came to the University of Illinois campus in 1940 as plant pathologist with the USDA. From 1949 until 1957, he hel a joint appointment with the USDA and the University. Durin most of this time he was chairman of the committee in charge c graduate work in plant pathology.

The Department of Plant Pathology was just two years old whe Dr. Bever became its first permanent head in 1957. Taking heterc geneous units that had been transferred from Agronomy, Horticu ture, and Botany, he welded them into a unified and outstandin department. He stimulated fundamental research by staff member encouraged the development of a sound extension program, an continually raised educational standards. While head of the depar ment, he served on the advisory boards of the Illinois Crop In provement Association and Illinois Foundation Seeds.

Of Dr. Bever's numerous scientific contributions, the most not worthy are his pioneering studies on the pathogenicity of *Puccini glumarum;* his early recognition of soil-borne wheat mosaic and h work in evaluating the resistance of new wheat varieties to this viru and his extensive studies on loose smut of wheat. He belongs to se eral professional societies and is a Fellow of the American Associ tion for the Advancement of Science. — *G. W. Salisbury*

Chemical Warfare In the Cornfield

Phytotoxic compounds released by weeds may be one cause of reduced yields

D. E. KOEPPE and DAVID T. BELL

For most of us, the phrase "chemical warfare in the cornfield" is likely to invoke visions of herbicide and pesticide applications by man. But in actuality a far more subtle type of chemical warfare is going on in our fields. This is the warfare between weeds and crops.

Almost from the beginning of agriculture, man has known that weeds often reduce the growth and yield of his crops. The plow and hoe, hand weeding, and to a lesser extent fire, flooding, smothering, and crop rotation have become agricultural practices for weed control throughout most of the world. Within the last several decades synthetic organic compounds have been developed which selectively kill certain plant species. In the developed countries of North America, Europe, and Australia these herbicides have to a great extent superseded the less efficient weed-control methods of bygone eras.

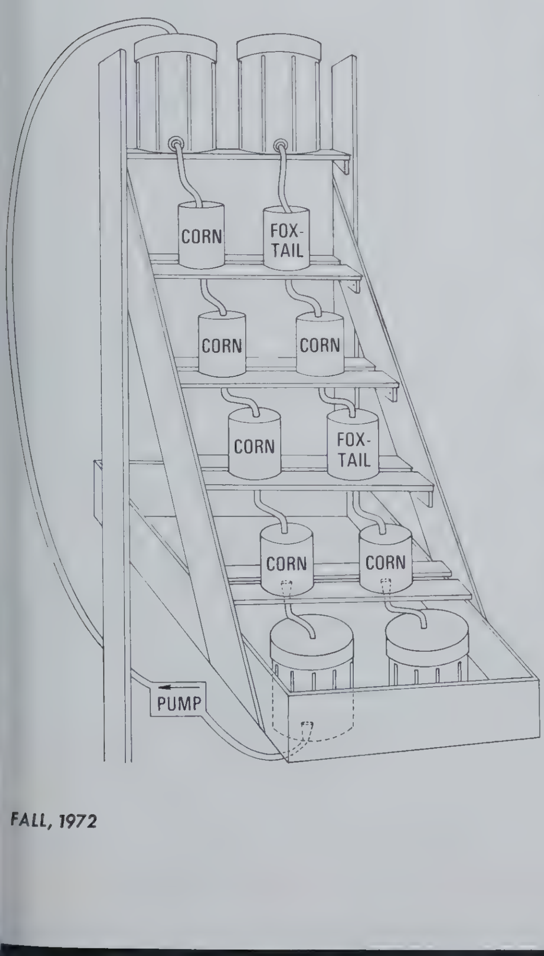
D. E. Koeppe is Assistant Professor of Plant Physiology, Department of Agronomy. David T. Bell is Forester, Department of Forestry.

How do weeds reduce yields?

Despite all our knowledge about weed control, we still are not certain as to just how weeds reduce crop growth and yield. The common explanation is that weeds compete with crops for nutrients, moisture, light, and possibly atmospheric gases. As a result of this competition, the proportion of a particular environmental factor available for a crop species is reduced below the level required for optimal growth. Thus, so the reasoning goes, removal of weeds simply provides more nutrients, moisture, light, and atmospheric gases for the crop plant.

Often it can be demonstrated in controlled experiments that increasing an environmental factor affecting a crop-weed association does increase the growth and yield of crop plants. These results substantiate the concept that the weeds are competing for the environmental factor.

But somewhat different results have also been obtained. The level of nutrients can sometimes be increased to satisfy the needs of all plants, both crops and weeds, and yet the growth of the crop plants will not be increased. When this happens, we can say that weeds and crop plants were not competing for nutrients. However, to make inferences about competition in general, all environmental



Above, Dr. Koeppe inspects foxtail growing on the stairstep apparatus used to determine crop-weed interactions due to phytotoxins. The apparatus is presented diagrammatically at left. (Fig. 1)

factors would have to be tested individually in separate experiments.

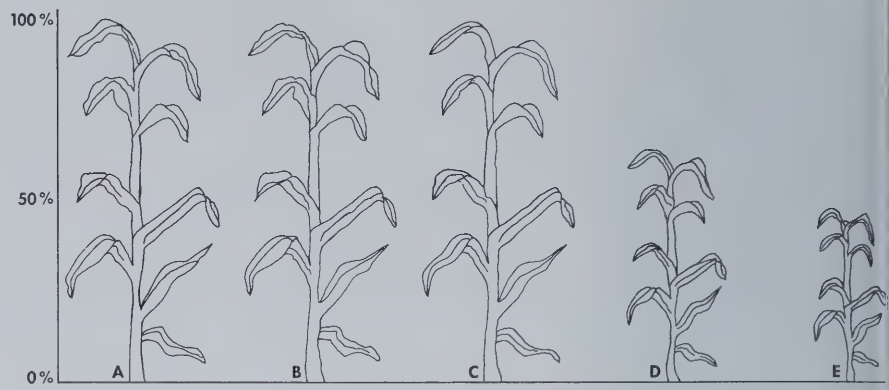
E. L. Knake and F. W. Slife at the University of Illinois have been conducting such experiments with giant foxtail in corn. They have found that competition alone will not completely account for the reduction of corn growth by the weed. Similar results have been obtained by Buchholtz at the University of Wisconsin, in experiments conducted with quackgrass and corn.

If not competition, then what? A possible explanation has been in the scientific literature for more than a century, but has been explored through research only in the last 20 to 25 years. As a result of this research, it has been established that many plants are leaky. Organic compounds are exuded from the roots and are leached from leaves by rain or mist. Could weed species release compounds that affect the growth of corn or, in other words, are phytotoxic to corn? Since competition alone does not fully explain the yield reduction caused by weeds, the possible effect of phytotoxic substances from weeds merits further consideration.

Plants on stairsteps

To determine whether giant foxtail produces phytotoxins that affect corn, a stairstep apparatus was constructed (Fig. 1). Two series of pots containing plants growing in pure quartz sand were arranged on the steps in descending order. The first series of pots contained only corn plants. In the second series, corn plants and foxtail plants were alternated. A water solution containing an adequate supply of all nutrients was circulated for several hours a day through each series of pots.

Corn grown in the first series of pots was compared with corn grown under identical conditions except that nutrients were not circulated from one pot to the next. Growth was essentially the same both with and without nutrient circulation, indicating that corn roots did not exude phytotoxins that affected the growth of other corn plants (Fig. 2).



Comparison of the dry weight of corn grown separately and in stairstep association with other plants: A, plants not grown in association with other corn or foxtail plants; B, plants grown in association with other plants; C, plants grown in association with foxtail seedlings; D, plants grown with mature foxtail; E, plants grown with dead foxtail incorporated into sand on the stairsteps. (Fig. 2)

Live foxtail exudes phytotoxins

Comparing the corn series with the corn-foxtail series, we found that young foxtail had little phytotoxic effect on corn plants during their first month of growth. However, when more mature foxtail plants were interspersed with the corn plants, corn growth was reduced by as much as 40 percent during the first month after germination. Under our experimental greenhouse conditions, foxtail roots evidently released one or more compounds that reduced the growth of corn. This possibly explains why previous research workers had been unable to attribute all of the foxtail-induced reduction of corn growth to competition.

Somewhat similar studies at Wisconsin have also led to the postulate that, in addition to competition between quackgrass and corn, there is an interaction attributable to phytotoxins released by the quackgrass.

Dead foxtail also important

While our greenhouse experiments suggest that phytotoxins are released from foxtail roots, several other possible modes of phytotoxin release may be even more important under field conditions. Two of these are the leaching of compounds from leaves, mentioned previously, and the release of phytotoxins from dead and decaying plant matter.

Decaying plant material may be the most important phytotoxin source in the field. Research workers at Nebraska have found that all plant residues used for stubble mulching, such as sweet clover, bromegrass, cornstalks, sorghum stalks, alfalfa hay, and wheat and oat straw contain phytotoxic substances. There is no reason why decaying weed species would not also release phytotoxins that could affect the growth of associated crops.

In our greenhouse experiments foxtail was killed by not watering it and then the dead plant material was incorporated into sand. Pots of this material were placed in stairstep association with corn as had been the living foxtail plants. The result was a significant reduction in the growth of corn (Fig. 2).

Field studies difficult

The preceding studies, performed in a controlled greenhouse environment, offer evidence that chemical warfare might go on in the cornfield under certain conditions. The magnitude and ecological importance of plants' phytotoxic effects are still unknown. Likely, such effects will differ with species, climate, soil, and moisture. Because of the many variables involved, it will be extremely difficult to define phytotoxic effects under field conditions. However, the possibility of phytotoxic activity should be at least suggested every time we observe a cornfield choked with foxtail growth.

The More Nitrogen in Corn, The Less in Our Water Supply

L. V. BOONE and L. F. WELCH

THE NITROGEN content of corn grain has long been of interest because of the positive relationship between nitrogen and protein content. Today, our concern about the effects of nitrogen fertilizer on water quality is adding a new dimension to our interest in the nitrogen content of corn. The reason is that corn grain accounts for most of the nitrogen hauled from Illinois fields in harvested nonleguminous crops. The higher the percent nitrogen in corn grain, therefore, the less nitrogen will be left in the soil to possibly enter the water supply.

In a previous study (ILLINOIS RESEARCH, 14,1), a balance-sheet approach was used to compare nitrogen added in fertilizer with nitrogen removed in nonleguminous harvested crops in Illinois. The commonly accepted value of 0.9 pound of nitrogen per bushel of corn (1.60 percent) was used to calculate the nitrogen removed in corn grain. However, the question arises as to whether Illinois corn typically contains 1.60 percent nitrogen. A study was therefore undertaken to determine the nitrogen percent in the grain of a number of varieties.

How study was made

Samples of grain were collected from experimental plots in the Illinois commercial corn trials at five locations (Fig. 1). All samples were grown at a high level of soil fertility.

Percent nitrogen was determined for 573 samples. To calculate nitrogen yield — or the nitrogen removed from the field in harvested grain — the percent nitrogen was multiplied by pounds of grain yield. All values reported are for corn with 15.5 percent moisture.

L. V. Boone is Agronomist and L. F. Welch is Professor of Soil Fertility, Department of Agronomy. The research reported in this article was part of a project on Nitrogen as an Environmental Quality Factor, supported by the Agricultural Experiment Station and the Rockefeller Foundation.

Percent and yield of nitrogen

The frequency distribution for percent nitrogen in corn grain is shown in Figure 2. Of the 573 grain samples, 19.2 percent contained between 1.36 and 1.40 percent nitrogen; 80.5 percent were between 1.22 and 1.49 percent; and 98 percent of the samples fell in the range of 1.14 to 1.62 percent. Average percentage of nitrogen in the grain was 1.38, as compared with the 1.60 percent used in the earlier study. The highest nitrogen percentage in any of the samples was 1.73; the lowest, 1.08.

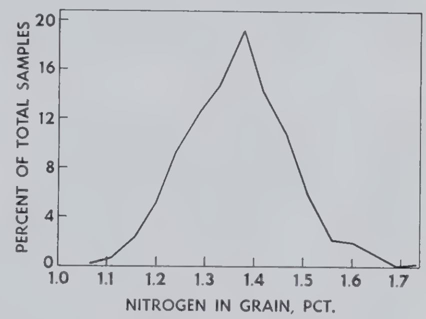
Average nitrogen yield was 99 pounds per acre, with 67.2 percent of the samples falling between 81 and 118 pounds per acre (Fig. 3). Average grain yield was 128 bushels per acre. On the average, 0.77 pound of nitrogen was removed from the field in a bushel of grain.

Environmental implications

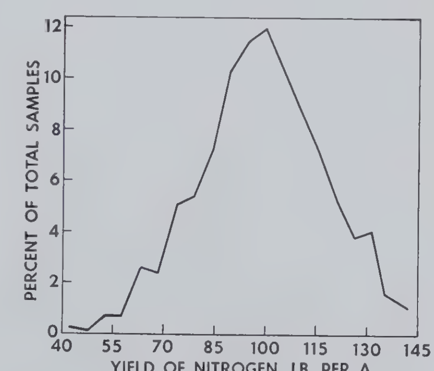
In 1971, 1,037,340,000 bushels of corn were harvested for grain in Illinois. If the grain contained 1.38 percent nitrogen, the average found in this study, 399,376 tons of nitrogen would have been hauled from the field. This would have been 67,427 fewer tons than if the grain had contained 1.60 percent nitrogen. More nitrogen would then have remained in the soil, some of which might have left the fields in water.

On the other hand, if all the corn harvested in Illinois in 1971 contained 1.73 percent nitrogen (the highest value found in our study), 503,110 tons of nitrogen would have been hauled from the fields, or 103,734 more tons than if the grain contained 1.38 percent nitrogen.

Locations of commercial corn variety trials from which grain samples were obtained. (Fig. 1)



Frequency distribution of different percentages of nitrogen in corn grain. (Fig. 2)



Frequency distribution of different amounts of total nitrogen per acre in corn grain. (Fig. 3)

Off-Farm Employment Earnings by Farmers With Low Farm Incomes

R. J. HANSON
and
R. G. F. SPITZE

Over half of the total net income earned by all Illinois farm families comes from off-farm sources, mostly wages and salaries.

As reported in the last issue of Illinois Research, the number of farmers working off the farm has been greatly increasing in recent years. To measure and analyze this trend, a statewide sample of Illinois farmers was surveyed. This report focuses on the farmers in the sample who received a low farm income, or less than $10,000 in gross farm sales, in 1971. These farmers made up 42 percent of the sample.

Average net farm income of the low farm income families was $1,450. To this, however, they added an average of $6,070 in wage and salary earnings by all family members, plus $844 from other off-farm sources. Thus, their average total family income was $9,364, well above any poverty standard.

Two-thirds of the farm operators with low farm income were working off the farm, averaging $4,750 in earnings. Of the high farm income farmers in the survey, only one-third worked off the farm, earning an average of $1,060 (Table 1).

Multiple regression analysis was used to help determine the farm, off-farm, and personal factors that significantly affected the off-farm earnings of low farm income farmers and wives. Table 2 presents simple and partial correlation coefficients between the farmer's wage and salary income (dependent variable) and each significant independent variable.

Table 1. — Average Farm Family Wage and Salary Income, 1971

Wage and salary income	All farmers	High farm income[a]	Low farm income[a]
Earned by farmer			
Off the farm....	$2,610	$1,060	$4,750
On other farms..	40	40	30
Earned by wife...	1,020	930	1,160
Earned by other family members	160	180	130
Total..........	3,830	2,210	6,070

[a] High farm income: $10,000 or more from gross farm sales. Low farm income: less than $10,000 from gross farm sales.

Table 2. — Correlation Coefficients Between Wage and Salary Incomes of Low Farm Income Farmers, and Significant Independent Variables

Independent variable	Correlation coefficients[a] Simple[b]	Partial[b]
Number of cattle........	(−.1226)	(−.0544)
Farmer's age...........	−.3656	−.0331
Farmer's education......	.3508	.1690
Number of children in family..............	.3957	.1867
Years of off-farm work experience..........	.4986	.2305
Number of days worked off the farm..........	.7544	.5118
Distance traveled to off-farm job............	.4323	.1939
Distance to nearest metropolitan city..........	(−.0924)	(−.0398)

[a] Correlation coefficients in parentheses are significant at the 5-percent level, with odds 19 to 1 against a chance correlation that large. Other coefficients are significant at the 1-percent level, with odds 99 to 1 against their being due to chance.
[b] In a simple correlation coefficient, all independent variables except the one being measured are ignored; in a partial correlation, they are held constant.

Farm characteristics

Characteristics associated with farm size generally had little effect on level of off-farm earnings, since most low farm income farmers had small operations. Acres, net farm income, gross farm sales, and number of cattle raised did vary inversely with wage and salary income. However, none of these was significant except for number of cattle, and even that had a small effect.

The minimal labor requirements of these small farms apparently did not prevent off-farm work, since three-fourths of the farmers in the group reported having time for some type of work in addition to farming. Probably even those not reporting idle time were underemployed on their farms.

Personal characteristics

Age of the farmer, his education, and family size significantly affected the level of off-farm earnings (Table 2). Farmers younger than 45 years averaged over $7,000 from off-farm work compared with only $1,140 for farmers older than 64 years. The negative simple (−.3656) and partial (−.0331) correlation coefficients indicate that off-farm earnings decrease with the farmer's age.

As shown in Table 3, wage and salary income increased as the educational level rose. Farmers with college degrees had by far the highest earnings. The positive simple (+.3508) and partial (+.1690) correlation coefficients corroborate this relationship (Table 2).

Large families evidently motivated the low farm income farmers to seek more income. Off-farm earnings increased steadily as the number of children living at home increased. Farmers with five or more children averaged $8,170 from off-farm employment; those with no children, $3,020. This relationship was supported by a strong positive simple correlation (+.3957).

Vocational training and the farmer's health were not found to be significant factors in the regression analysis. However, both had some effect on off-farm employment earnings. Farmers with vocational training earned a higher wage and salary income ($5,460) than those without it ($5,020). Those in good health

R. J. Hanson was formerly Research Assistant, and R. G. F. Spitze is Professor, Department of Agricultural Economics.

Table 3. — Average Wage and Salary Income Earned by All Low Farm Income Family Members, by Educational Level of Farmer

Wage and salary income	Farmer's educational level				
	Grade school	Some high school	High school	Some college	College degree
Earned by farmer					
Off the farm	$2,820	$5,070	$5,940	$4,920	$12,160
On other farms	40	20	40	10	0
Earned by wife	800	1,260	1,330	1,540	1,920
Earned by other family members	150	260	20	220	150
Total	3,810	6,610	7,330	6,690	14,230

Table 4. — Average Wage and Salary Income of Low Farm Income Farmers, by Years of Experience[a]

Years of off-farm work experience	Farmers' earnings	Wives' earnings
2 years or less	$5,950	$2,120
3 to 5 years	$7,390	$3,530
6 to 11 years	$8,990	$4,340
12 years or more	$8,910	$5,680

[a] Includes only those working off the farm.

Table 5. — Average Wage and Salary Income of Low Farm Income Farmers, by Distance to Jobs[a]

Distance traveled to off-farm jobs	Farmers' earnings	Wives' earnings
3 miles or less	$7,610	$3,760
4 to 9 miles	$7,740	$3,930
10 to 14 miles	$6,840	$3,540
15 to 24 miles	$8,910	$3,350
25 miles or more	$9,010	$4,590

[a] Includes only those working off the farm.

Table 6. — Average Wage and Salary Income of All Low Farm Income Farmers, by Distance to Nearest City

Distance from farm to nearest metropolitan city	Farmers' earnings	Wives' earnings
25 miles or less	$6,170	$1,340
26 to 50 miles	$4,740	$1,120
51 to 75 miles	$4,920	$1,240
76 to 100 miles	$4,670	$ 960
101 miles or more	$4,680	$1,090

earned more (over $5,600) than those in poor health ($1,590).

Employment characteristics

Both farmers and wives earned higher wages and salaries as years of experience at a particular off-farm job increased (Table 4). The simple correlation coefficients for farmers (+.4986) and wives (+.5821) support this relationship. Farmers had worked at their present job an average of 13 years; wives, 9 years.

Earnings tended to increase with the number of miles traveled to the job (Table 5). This was further indicated by the positive simple correlations (+.4323 for farmers and +.5104 for wives). Farmers traveled an average of 16 miles to their work; wives, 10 miles.

As expected, wage and salary income increased as more days were worked off the farm (Table 2). Farmers working 300 days or more averaged $9,650; those working 99 days or less, $1,300. The group as a whole worked an average of 240 days a year off the farm.

Off-farm employment opportunities should increase with proximity to metropolitan cities. And indeed farmers and wives living 25 miles or less from the nearest metropolitan city averaged the highest wage and salary incomes (Table 6). Beyond 26 miles, however, distance did not appear to have much effect. The negative simple correlations (−.0924 for farmers and −.0410 for wives) also indicate a minor relationship exists.

Policy implications

Of the low farm income farmers in this study, 88 percent had a net farm income of $3,000 or less; yet they supplemented this by an average of $6,130 from off-farm sources. People responsible for public policy must therefore take care to identify the real poverty farmers, or those whose combined farm and off-farm income is inadequate.

About 20 percent of all Illinois farm families received a total income of $5,000 or less in 1971. Many of these families are more appropriately the concern of public welfare policies than of policies to improve labor productivity. According to the present study, farmers that were over 65 years of age, inadequately educated, or in poor health were generally earning both the lowest net farm income and the lowest off-farm income.

Most low farm income farmers want off-farm employment opportunities. During 1971, 66 percent of Illinois farmers in this category reported working off the farm, and 15 percent of those not working off the farm indicated that they would like to do so. Job training, adult education, employment services, and relocation assistance programs can help.

Public programs designed to improve off-farm employment, and hence alleviate rural poverty, should offer a degree of job permanence. Most low farm income farmers stay with their jobs, 45 percent having worked at their present jobs 12 years or longer and only 15 percent for two years or less.

This study also suggests that low farm income farmers and farm wives are willing to travel some distance for adequate earnings. Industries are not needed in every rural community. Instead, they should be located in only a few of the rural areas with the greatest economic advantages, and should be coupled with programs to improve farmers' mobility.

The majority of the low farm income farmers seem to want to stay in agriculture. Only 9 percent of these farmers in Illinois expected to give up farming in the next five years. Almost none indicated that a desire to leave farming was the reason for working off the farm.

Most of Illinois's low farm income farmers seem to have satisfactorily combined farm and off-farm employment, raising themselves out of the poverty stream. Public policy needs point to improved off-farm employment opportunities for most low farm income farmers and welfare assistance for the remainder.

Forty Boys Show How They Can Wear Out Two Types of Jeans

CAROL L. WARFIELD

DURABLE PRESS finishes, combined with recent improvements in automatic washers and dryers, have enabled many homemakers to almost abandon their irons and ironing boards.

However, despite the advantage of muss resistance during wear and laundering, these finishes are far from perfect. They lower the strength and elongation of cotton fibers and consequently reduce the abrasion resistance or durability of a garment. This lowered abrasion resistance is frequently noted on hems, creases, collar points, and other edges of the garment. In addition, it has proved extremely troublesome in boys' trousers, causing holes in the knees long before there are other signs of wear.

One approach to the problem has been to blend polyester fibers with the cotton. The polyester fiber is inherently strong and abrasion-resistant, and has good crease recovery characteristics. It is not affected by the resins in durable press finishes. Thus, polyester contributes to durable press characteristics of the blend as well as to overall fabric strength. Cotton-polyester blends with durable press finishes have proved quite satisfactory for many garments. However, boys' jeans are still bursting out at the knees before they should.

Two types of jeans compared

In the summer of 1970 a study was initiated to compare the wear in two types of jeans. One type (which will be referred to as PC jeans) was made of a fabric that was 75 percent polyester and 25 percent cotton with a durable press finish. The other type (C jeans) was made of 100 percent cotton. This fabric did not have a wrinkle-resistant finish, but it did have a Sanforized finish, which is supposed to limit garment shrinkage to 1 percent.

Carol L. Warfield is Instructor in Textiles, Department of Home Economics.

The two kinds of jeans were closely matched in fabric weave (3/1 twill), fabric weight (11 ounces per square yard), color (navy), and construction details (western style with straight legs). In the C jeans the inside of the knee was reinforced with a stiff woven patch similar to the iron-on patches available to consumers. The PC jeans were reinforced at the knee with a thin plastic film that adhered to the fabric.

Forty boys, 8 to 10 years old, participated in the study. Each received a pair of jeans of each fabric, and was assigned to a wear period — either 5, 15, 30, or 45 wearings for both pairs of jeans. A wearing was to last through a normal day's activities. Since the boys began wearing the jeans in the fall, football was a popular pursuit.

After each wearing the jeans were returned to the Textiles Research Laboratory for laundering, so that variations in laundry equipment would not affect the results. (It has been shown that nicks and scratches in the tub or dryer drum can affect a garment's durability.)

The jeans were worn until (1) the specified wear period was completed, (2) one or both knees were worn completely through, or (3) the jeans no longer fit the boy. If a boy outgrew his jeans (as did seven of the boys assigned to the longer wear periods), an attempt was made to find another boy that could wear the jeans until the designated wear period was completed.

Table 1. — Percentage of Jeans That Lasted for Specified Number of Wearings

Number of wearings	C jeans	PC jeans
	pct.	pct.
5	100	100
15	60	44
30	40	30
45	0	0
No wear, 45 washings	100	100

One set of jeans was kept as a control, and another set was laundered 45 times with no wear.

Methods of analysis

When the jeans were distributed, each mother was given a data sheet for recording the dates and length of time of wearing, as well as the type of activity for which the jeans were worn. Questionnaires were also given out to determine the mothers' and the boys' reactions to the jeans. Data sheets and questionnaires were turned in when the jeans were returned to the laboratory for retirement.

After all the jeans were retired, a panel of three of the mothers was asked to rate the jeans on the basis of five appearance factors: (1) seam smoothness, (2) overall fabric smoothness, (3) retention of stitching, (4) signs of wear or abrasion, and (5) retention of color.

An additional phase of the study, which has not yet been completed, is microscopic analysis of the jeans. For this analysis photomicrographs were made of certain areas of the fabrics, of yarns removed from various areas of the jeans, and of cross-sections of fabric from several areas. Photomicrographs have also been made of fabrics given laboratory abrasion treatment.

All the photomicrographs will be compared to try to determine whether there are any common factors in the breakdown mechanism of the fabrics. If any such factors could be found, the garment industry could more accurately predict the performance to be expected from boys' jeans. At the

moment there is no known laboratory test that will accurately reproduce a little boy's ability to burst the knees of his jeans.

Length and type of wear

The longest period set up for the wear study turned out to be unrealistic. It had been assumed that 45 wearings would roughly approximate one year's wear if jeans were worn once a week, or six months' wear if they were worn twice a week. However, none of the jeans lasted through 45 cycles of wear and laundering (Table 1). The longest that any of the jeans lasted was for 33 wearings. One pair (originally designated for 45 wearings) gave out at the knee after only four wearings.

The two types of jeans differed in the wear pattern at the knees. The knee reinforcements in the PC jeans were very flexible and lightweight. As noted in Table 1, these jeans wore out faster than the C jeans. Although the plastic film did help to prolong the life of the knee, the boys were quite capable of wearing through both the jeans fabric and the film. A fused appearance, so far unexplained, was often noted next to a hole or to an area that later became a hole.

None of the boys managed to wear a hole through both the C jeans fabric and iron-on patch. However, some of these patches came off during wearing or laundering. A few were even removed in early launderings of jeans that had never been worn. C jeans, minus knee reinforcements, were more likely to be worn through than either type of jeans with reinforced knees.

When the patch stayed in place on C jeans, the jeans often wore out around the patches after 25 to 30 wearings. The heaviness of the patches caused a distinct difference in fabric thickness at the edges of the patches, accounting for the localized wear in these areas.

Appearance

Although the PC jeans didn't wear as long as the C jeans, they looked better throughout the time they were worn. At the higher wear levels, the top stitching on the seams and pockets of the C jeans often broke and was partially removed. This didn't happen on the PC jeans. These jeans also kept their color better than the C jeans. Even without wearing, C jeans that were laundered 45 times showed a definite loss of color.

Table 2. — Seam and Overall Fabric Smoothness as Rated by Panel[a]

Number of wearings for which jeans were designated	Seam smoothness		Fabric smoothness	
	C jeans	PC jeans	C jeans	PC jeans
0 (control)	4.9	4.9	4.5	4.5
5	3.3	4.1	2.7	4.3
15	2.7	3.7	2.5	4.1
30	2.8	3.7	2.6	4.2
45	3.4	3.6	2.6	4.2
45 washings	2.2	4.1	2.8	4.4

[a] A rating of 5 was the highest possible.

Seams were much smoother on the PC jeans than on the C jeans. The flat-fell seams on the C jeans, with their double row of stitching, tended to pucker more after laundering than did the single-stitched overcast seams of the PC jeans. Nearly all durable press garments are now made with single-stitched seams to overcome a natural tendency to pucker.

In addition, the PC jeans retained their fabric smoothness quite satisfactorily in all but the longest wear period (Table 2). Even then, the PC jeans which were worn the longest looked smoother than any of the C jeans except the controls.

Other appearance factors were observed in the laboratory but were not mentioned by the boys, their mothers, or the panel. One was the fact that almost all the legs of the C jeans were cut off grain. Consequently it was almost impossible to fold the jeans neatly or to get them to hang straight on a boy.

Some of the PC jeans exhibited a different problem — the appearance of little pills on the fabric surface. This tendency was not necessarily associated with increasing levels of wear, but seemed rather to vary with the individual wearing the jeans. The area most prone to pilling was the inside of the thighs, where there would tend to be the most rubbing. However, on some jeans the whole surface was covered with pills.

Other observations and problems

Some participants noted that their jeans — particularly the C jeans — became tighter and shorter as the wear period progressed. This tendency was due not only to the boys' growth but to fabric shrinkage. Even with the Sanforized finish, the C jeans showed some progressive change in size after repeated launderings.

A frequent complaint of the participants was that the snaps of the jeans were difficult or impossible to operate. This complaint was evenly distributed between both types of jeans. In addition, the hems in the PC jeans frequently came out during the early launderings, thus requiring restitching.

Dirt and grass stains were not much of a problem with the laundering method used. This method consisted of pretreating knees and other soiled areas with liquid detergent, then washing the jeans in hot water with a low-suds detergent.

However, green color frequently showed through the plastic film patches on the inside of the knees of the PC jeans. Apparently grass stains were still present although not readily seen on the face of the fabric. This might have been more of a problem on lighter colored fabrics. It is not known whether the plastic film itself was holding on to the stain, or whether the film simply hindered complete removal of the stain.

Which is better?

It cannot be said that one type of jeans performed better than the other. The choice between the two depends entirely on the criteria deemed important by the boy and his parents. A mother, for example, might prefer the durable press jeans because of their appearance and ease of care. Her son, however, might prefer the worn, faded look of the cotton jeans that seems to be favored by the younger generation.

THE COMPACT APPLE TREE
For Commercial and Home Plantings

ROY K. SIMONS

DWARF fruit trees, especially apple trees, are becoming increasingly popular among both commercial and home growers in the Midwest.

Commercial growers like the dwarf trees for several reasons. More trees can be grown per acre, utilizing both land and labor more effectively than when standard trees are grown. Compared with standard trees, dwarf trees usually start bearing several years earlier, they are easier to spray and prune, and the fruits are easier to pick. Also, this system of tree growth takes advantage of all possible sunlight to produce a high-quality product for the market.

Eight-year-old Golden Delicious on (1) EM IX, (2) EM VII, (3) MM106, and (4) seedling rootstocks.

Homeowners find that the compact fruit tree is adaptable in landscaping or in utilizing small garden areas. With diligent care, a home grower can produce an excellent product from his trees.

Spacing of trees

The relative size of several dwarf rootstocks is indicated in Table 1. A standard size seedling tree is considered to be 100 percent, while dwarf stocks range from 30 to 80 percent of this size. The table may be used as a guide in determining the number of trees to plant.

Successful plantings depend upon a well-defined soil type and availability of irrigation water. Illinois soils are such that trees will usually grow larger here than in such states as Michigan and New York. Therefore, a medium-density planting of about 200 trees per acre is usually preferred to maintain equipment through the row middles. For the larger of the dwarf rootstocks, such as East Malling II, rate per acre would be decreased; for an extreme dwarfing type like EM IX, the rate would be increased.

Suggested dwarf rootstocks

Following is a list of some suggested dwarf rootstocks for several apple varieties:

Red Delicious (spur types). East Malling II and VII; Malling Merton 106 and 111. EM IX for high density plantings (8 by 14 feet, equaling 390 trees per acre; these trees will require staking and trellising).

Golden Delicious. EM VII, II, and 26; MM 106 and 111.

Golden Delicious (spur types). EM VII, MM 106 and 111.

Jonathan. EM VII and 26; MM 106 and 111.

East Malling XXV and Alnarp 2 will produce trees similar to those

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The author records yield on a 3-year-old Red Spur (a Red Delicious spur type) on EM IX rootstock. Note fruit production at this early date. Fruit should be removed from these young trees to insure good future production.

Table 1. — Size Index for Use in Tree Spacing

Apple rootstock	Expected size, pct.
Seedling	100
Alnarp 2	100
East Malling XXV	100
Malling Merton 104	90
Malling Merton 109	90
East Malling II	80
Malling Merton 111	75
Malling Merton 106	70
East Malling VII	50
East Malling 26	40
East Malling IX	30

grown on seedling rootstock. However, EM VII, IX, and 26 will produce significantly dwarfed, compact trees. A spur type Red Delicious on Malling Merton 111 should produce an excellent tree.

Yields at University

Dwarf apple trees have been grown at the University since 1954. The first trees were planted in a modified hedge row and are currently producing fruit on a commercial basis. Subsequent plantings were made in 1957, 1963, and 1971.

In 1963 Golden Delicious, Red Prince, and Jonared were planted on 10 dwarfing rootstocks: Malling Merton 104, 106, 109, and 111; East Malling II, VII, IX, XXV, and 26; and Alnarp 2. As shown in Tables 2, 3, and 4, production began to be significant after 5 years' growth, and in 1970 (after 7 years' growth) the trees began to produce a commercial crop. By comparison, Golden Delicious on a seedling rootstock, planted in 1963, has not yet begun to bear fruit on a commercial scale.

Additional information can be obtained from the county Extension advisers or from the Extension fruit specialist, University of Illinois at Urbana-Champaign.

Table 2. — Five-Year Yield Record for Golden Delicious Growing on 10 Dwarfing Rootstocks Planted in 1963

Rootstock	1967		1968		1969		1970		1971	
	No. of trees	Av. lb. per tree	No. of trees	Av. lb. per tree	No. of trees	Av. lb. per tree	No. of trees	Av. lb. per tree	No. of trees	Av. lb. per tree
MM 106	14	15	14	172	13	181	9	358	10	407
MM 111	12	11	12	108	12	65	12	247	10	253
MM 109	12	23	12	102	12	127	12	276	10	311
MM 104	11	5	11	111	11	87	11	268	10	182
EM XXV	8	4	7	99	7	110	7	244	5	209
Alnarp 2	8	8	6	112	6	90	6	250	5	245
EM VII	11	18	11	155	11	153	11	310	10	169
EM II	12	11	11	123	11	145	11	296	10	199
EM 26	4	20	4	218	4	252	4	368	5	336
EM IX	6	37	3	153	3	58	3	276	..	...

Table 3. — Five-Year Yield Record for Red Prince (a Red Delicious Strain) Growing on 9 Dwarfing Rootstocks Planted in 1963

Rootstock	1967		1968		1969		1970		1971	
	No. of trees	Av. lb. per tree	No. of trees	Av. lb. per tree	No. of trees	Av. lb. per tree	No. of trees	Av. lb. per tree	No. of trees	Av. lb. per tree
MM 106	13	5	11	33	12	37	13	312	8	241
MM 111	12	5	9	18	11	24	12	180	10	147
MM 109	10	5	11	25	8	25	8	300	10	212
MM 104	12	6	7	27	7	20	5	302	10	102
EM XXV	8	6	7	26	7	33	7	200	6	140
Alnarp 2	8	8	3	31	3	15	3	216	6	214
EM VII	13	7	10	37	8	41	8	258	10	193
EM II	11	11	9	30	9	57	7	282	10	159
EM 26	4	5	3	54	3	135	2	300	2	190

Table 4 — Five-Year Yield Record for Jonared Growing on 10 Dwarfing Rootstocks Planted in 1963

Rootstock	1967		1968		1969		1970		1971	
	No. of trees	Av. lb. per tree	No. of trees	Av. lb. per tree	No. of trees	Av. lb. per tree	No. of trees	Av. lb. per tree	No. of trees	Av. lb. per tree
MM 106	11	16	10	59	10	223	10	220	10	280
MM 111	12	11	11	65	10	165	9	228	10	153
MM 104	11	9	10	53	10	152	10	228	9	185
MM 109	12	10	12	58	10	154	12	196	7	135
EM XXV	8	14	6	85	6	163	1	190	5	110
Alnarp 2	8	23	7	71	6	208	6	152	2	198
EM VII	12	12	10	78	10	143	10	192	7	252
EM II	13	13	11	66	11	185	11	227	9	190
EM 26	4	23	4	100	4	257	3	186	2	300
EM IX	4	23	1	55	1	160	..	...	..	...

A Dairying Revolution in India To Match the Green Revolution?

E. E. ORMISTON

THE GREEN REVOLUTION in India has rated the headlines and stirred the aspirations of her people. Although less dramatic, a revolution seems also to be occurring in India's dairy industry.

The traditional veneration of the cow, together with the Indians' taste for milk and milk products, is being turned to advantage for the improvement of cattle and dairy production. Modern science is providing the necessary tools and techniques.

I had the opportunity to observe and participate in some of the changes during two assignments in India. The first as Dairy Science and Extension Adviser at Banaras Hindu University from February, 1961, to August, 1963; the second, as Dairy Science Adviser at the U.P. Agricultural University (now the G. B. Pant University of Agriculture and Technology), Pant Nagar.

The Indian dairy industry

The government of the several states, the National Dairy Development Board, the Indian Council of Agricultural Research, the Ministry of Agriculture, and other governmental agencies have generously supported the animal industry, particularly the dairy industry, since India gained her independence in 1947. And this has been done in spite of wars, industrialization, poverty, the overwhelming press of population, and the urgency to produce food grains for the people. A further handicap has been that India has no tradition of dairy husbandry as we know it in the West.

Although India has about 232 bovines, only about 55 million cows and 27 million buffaloes above three years of age are kept for milk production. The rest are young stock, bullocks, cattle kept to produce bullocks and dung, and ownerless strays.

Little can be done about eliminating the surplus cattle, because some states completely prohibit the slaughter of cows, while most of the others permit slaughter only of cows over 15 years of age. The various states do support 79 areas called gosadans, where old, infirm, unproductive, and stray cattle are cared for.

The Indian government estimates that cows kept for milk production average about 500 pounds of milk a year; buffaloes, 1,150 pounds. Although buffaloes represent only one-third of the bovines kept for milk, they produce 55 percent of the total.

About 90 percent of India's milk comes from small farms with only two to five cows or buffaloes, which are usually cared for by the women and children. The farm families consume 60 to 70 percent of the milk and market the rest, which amounts to 7 to 10 pounds a day.

Larger herds of several hundred to a thousand head are kept at state government farms. In addition are milk colonies which may contain thousands of animals. For example, the Aarey Milk Colony near Bombay has 17,000 milking buffaloes, the largest buffalo herd in the world. And around the major cities, large numbers of cows and buffaloes are kept by landless owners.

Major dairy products consumed in India include ghee (clarified butter in semi-liquid form), dahi (curd), butter, khoa (partially evaporated milk used primarily for making candy and sweets), khlurchan (clotted milk solids obtained by scraping the flakes from the sides of an open evaporating pan), ice cream, and infant foods. An estimated 30 to 40 percent of the total milk produced is consumed in the fluid state, mostly in tea.

The Indian government estimated in 1971 that the available milk amounted to a little more than 4 ounces per person per day, as compared with the minimum requirement of 10 ounces recommended by the Nutritional Advisory Committee of the Indian Council of Medical Research. The goal is 6 ounces per person per day in the near future and 10 ounces in the long run.

In early 1971, 106 dairy plants were in operation. Of these, 60 were liquid milk plants; 7, milk products factories; 3, creameries; and 36, pilot milk schemes. There is a network of milk collection centers from which milk is hauled in refrigerated trucks to the major cities. Average daily output of milk from all dairy plants was about 5 million pounds in 1970-71, 600,000 pounds more than in the previous year.

In addition to the dairy plants and milk schemes, the government has set up intensive cattle development programs and has established laboratories to produce vaccines for the control of foot and mouth disease, rinderpest, and other diseases. There is a well-supported National Dairy Research Institute, and 15 land grant type agricultural universities have been started within the past 12 years. Finally, the government is taking several steps to improve herds by means of artificial insemination and crossbreeding.

Artificial insemination

Artificial insemination has a long history in India. J. D. Sampath Kumaran, now on the staff of the G. B. Pant University, learned the technique of AI in Israel in 1938 and

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Economics of Indian Milk Production[a]

Type of bovine	Age 1st calving, yr.	Total no. of calvings	Life-time yield, lb.	Feed cost, cents per qt.
Average cow	4	6	6,600	21.5
Farm-bred cow	4	6	13,200	13.6
Average buffalo	4	5	12,000	14.4
Farm-bred buffalo	4	5	16,500	11.3
Average crossbred cow	3	7	30,800	9.0
Superior crossbred cow	3	7	38,500	7.8

[a] Data from a paper published by M. L. Mather, National Dairy Research Institute, Bangalore, 1968. Original measurements were in liters and rupees, which have been converted to pounds, quarts, and cents.

successfully used it on more than 30 cows in India in 1939.

In 1942 experimental work on artificial insemination was started at the Indian Veterinary Research Institute, Bareilly, and the Madras Veterinary College. According to Dr. Kumaran's estimates, more than 555,000 cows and buffaloes had been artificially inseminated in India by 1960.

Several cattle breeding farms are now maintained by the government to provide bulls for AI, and the importation of frozen semen from Western countries is encouraged. Networks of AI centers and substations, most of which include dispensaries, have been set up by the state governments.

Unfortunately, the AI centers and substations are usually ill equipped and frequently without refrigeration, and the technicians are all too often poorly trained. The cows, which are led or driven to a center or substation for insemination, are often undernourished or infected and not at the stage of estrus optimum for conception. It is small wonder that the average conception rate is about 25 percent.

Punjab, about three-fifths the size of Illinois, is generally considered to be one of the most progressive states in India. According to a report made in June, 1972, the Punjab state government has established 44 AI centers and 201 substations. The AI service, on the average, was 29.31 percent successful with cows and 7.79 percent with buffaloes.

These conception rates differ little from the results obtained during my tour of duty at the U.P. Agricultural University. For the year ending April, 1971, we had 196 conceptions from 834 inseminations, for a conception rate of 23.5 percent.

Genital infections were prevalent. Of 268 cows observed in estrus during the year, 111 or 41.4 percent showed genital infections requiring treatment before insemination. These cows had a conception rate of 19.7 percent, as compared with 48.9 percent for uninfected cows.

There was a marked improvement during the last six months of my stay. Some 80 problem cows were disposed of, infections were reduced, and the technique of breeding was improved. A former colleague wrote me in June of 1972 that the conception rate for the herd was almost 50 percent.

The present status of AI in India still leaves much to be desired. However, progress is being made under much more difficult conditions than existed in the United States when AI was introduced here.

Crossbreeding

Recognizing the genetic limitations of most indigenous cattle for milk production, the Indian government is encouraging crossbreeding with bulls of European breeds. One generation of crossbreeding can increase yield more than 50 years of selective breeding of native cattle.

Crossbreds have been utilized at some military farms since 1900. In 1924 the Allahabad Agricultural Institute started a well-organized crossbreeding program with European bulls on indigenous breeds. More recently the crossbred progeny of imported Jersey bulls and Jersey bulls produced by the government farms at Bangalore and elsewhere have demonstrated their superiority.

The National Dairy Research Institute at Karnal first used imported frozen semen from Holstein and Brown Swiss bulls in 1962, and have an excellent crossbred herd. At the Indian Agricultural Research Institute, New Delhi, Holstein cows and bulls have been imported from Australia and many Sahiwals have been crossed with the Holsteins.

Meanwhile, the Indo-Swiss project in Kerala and the Indo-Danish project at Bangalore demonstrated the superiority of Brown Swiss × native and Red Dane × native crosses, creating demand for bulls from these projects. In 1971 Denmark contributed a shipment of Red Dane bred heifers and bulls, which were distributed to four locations, including U.P. Agricultural University.

Crossing exotic dairy bulls with native cows has increased milk production by about 100 percent when cows have been given adequate care. At U.P. Agricultural University, for example, Jersey crosses calved a year younger than their Sahiwal dams and produced 90 percent more milk during their first lactation. Similar results have been obtained elsewhere, as shown in the table.

The superior performance of crossbred cows is well recognized in India. Farmers near the U.P. Agricultural University were willing to pay 75 rupees for the successful insemination of their cows with frozen semen. And a rupee is harder to come by there than a dollar is here. The government is also making scarce foreign exchange available to pay for frozen semen from other countries.

India has a body of qualified scientists in animal genetics, veterinary medicine, food technology, agricultural economics, and related fields, and the new agricultural universities are adding more to the group. Recognizing that time is short and the need for better cows is urgent, they are marshaling India's own resources, plus help from other countries, to vitalize the Indian dairy industry.

The Changing Eskimo Diet

Adding commercial foods to the traditional diet of northern Alaskan Eskimos has relieved some nutritional problems but has created others

H. H. DRAPER and R. R. BELL

In most of the world, a balanced diet of fruits, vegetables, cereals, meat, and dairy products is considered essential for good health and an active life. But Eskimos in the far north have for generations maintained a rigorous life style on a diet consisting almost entirely of meat and fish.

How do they do it? This question has long fascinated nutritionists. Some answers are now being sought in studies conducted under the auspices of the International Biological Program. As part of these studies, the nutrition of Eskimos living in the villages of Wainwright and Point Hope, Alaska, is being investigated under the direction of personnel from the Department of Food Science of the University of Illinois. Staff members of the University of Illinois Health Service, Vanderbilt University, and the University of Rhode Island are collaborating on the project. Financial support is being provided by the National Science Foundation.

Purpose of the study is to examine not only the processes by which the Eskimo adjusted to a restricted native diet, but also the processes by which he must now adapt to the diet of a modern society. It is further hoped that answers about the Eskimos will hold important lessons for the nutritional well-being of modern man.

General aspects of diet

Above the Brooks Range in Alaska, caribou, whale, and seal form the staples of the traditional diet. Walrus, fish, and birds are of minor importance, and edible plants and berries are scarce. The belief that Eskimos commonly consumed the stomach contents of caribou, which feed mainly on lichens, and thereby received the benefit of plant foods, is debatable.

The traditional diet of the northern Eskimo, therefore, consisted almost entirely of foods of animal origin. Most of these foods were eaten raw, frozen, or lightly cooked (Eskimo means "eater of raw flesh"). Such a diet is notably high in protein and fat, and low in carbohydrate.

Protein

The native Eskimo diet contains more protein than that of any other ethnic group of comparable size. The protein consumed beyond that necessary to meet the body's amino acid requirements serves two important functions: as a source of calories, maintaining a physically active life, and as a source of blood glucose, which is an essential metabolic fuel for the nervous system.

Carbohydrate

Since the Eskimo's native diet normally contained only a small amount of carbohydrate (in the form of glycogen), his essential glucose requirements had to be met by biosynthesis from dietary amino acids. The virtual nonexistence of diabetes among Eskimos until recent years may offer a clue to the role of diet in this disease. Since the introduction of processed foods, the incidence of diabetes has steadily increased.

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Eskimo woman prepares to butcher a spotted seal taken at Wainwright in August, 1971.

Some modern Eskimos are apparently experiencing difficulty in digesting and metabolizing the substantial quantities of sugar that they are now encountering in processed foods. After weaning, Eskimos traditionally have consumed a diet essentially devoid of milk and milk products. Consequently the intestinal level of lactase, the enzyme required for digestion of milk sugar, is lower than in most Western populations, although about the same as in Eastern peoples. However, tests indicate that adults can digest the amount of lactose in at least one glass of milk without gastrointestinal distress.

Glucose load tests on fasted, adult Alaskan Eskimos have not revealed any abnormalities in blood glucose or insulin response. These results contrast with a report that Canadian Eskimos often exhibit an abnormal rise in blood sugar and insulin after glucose administration.

Whether some Eskimos have a limited capacity to digest sucrose is another interesting aspect of their adaptation to processed foods. The absence of sugar in the diet for centuries may have reduced the intestinal level of sucrase, the sucrose-splitting enzyme. Several Eskimos have been identified who experience indigestion and diarrhea after consuming sucrose-containing foods and beverages. These individuals will be studied more intensively to establish their intestinal levels of sucrase and their ability to cope with the high sugar content of many processed foods.

Fat

Whale, seal, and walrus oils constituted an important source of calories in the native diet. The biochemical processes by which the fatty acids in these oils were utilized for energy, and their influence on the composition of body fat and cell membranes, constitute one of the unique aspects of Eskimo nutrition.

Consumption of high-fat, low-carbohydrate diets causes ketone bodies to form in the liver. Experiments with animals have shown that, over time, most tissues can adapt to the utilization of ketone bodies instead of glucose as a source of energy. Eskimos may represent a modern human example of this metabolic phenomenon.

Vitamin C

Although scurvy is generally associated with a lack of fresh fruits and vegetables, Eskimos have apparently escaped its effects despite the virtual absence of these foods from their native diet. Evidently foods of animal origin provided enough vitamin C to prevent scurvy. The Eskimo habit of eating fish and meat in a raw, frozen, or lightly cooked state protected the modest amounts of vitamin C in these foods from oxidation and leaching. Where berries were available, they were stored in sealskin bags (seal pokes) under oil, which prevented oxidation of vitamin C.

The substantial levels of vitamin C found in the blood of most Eskimos today reflect the addition of processed foods to the traditional diet.

Fat-soluble vitamins

The fat-soluble vitamins A, D, E, and K apparently presented no nutritional problems for the Eskimo. Although β-carotene, the main precursor of vitamin A in plants, was in short supply, the preformed vitamin was abundantly available in the oils of fish and marine animals. In fact, concentrations of vitamin A in the liver of the polar bear are sometimes high enough to be toxic, causing the Eskimos to avoid this food.

Vitamin D was available from the same sources as vitamin A. Eskimo children probably have to depend entirely on their diet for vitamin D. During the long winter they must be so assiduously protected against the cold that little vitamin D can be generated in the skin by irradiation.

Cereal grains, generally the richest dietary source of vitamin E, were absent from the native diet. Fats and oils of animal origin contain substantially less vitamin E than those of plant origin. Nearly all the vitamin E in animal tissues, however, is present in its most active form (α-tocopherol), whereas much of the vitamin E in cereals occurs in less active forms. This would explain why the concentration of vitamin E in the blood of northern Alaskan Eskimos is similar to that found in the blood of people accustomed to a varied diet.

B vitamins

At Wainwright, where native foods still constitute a major part of the diet, urinalysis indicates that Eskimos of all ages are obtaining an abundant supply of B vitamins. This is attributable to the high B vitamin content of caribou meat and other foods of animal origin. In this respect, as in most others, the native diet supports a nutritional standard at least equal to that found in an affluent modern society.

Minerals

By U.S. standards, the Eskimo diet is low in calcium although it contains liberal amounts of other essential inorganic elements. Historically, young children obtained their calcium needs during a long nursing period. Adults got some calcium from eating whole, frozen fish and the spongy portion of animal bones. However, this was only about half as much as is currently recommended. Eskimos still don't consume much milk or dairy food, so their calcium intake remains below prevailing standards.

The low calcium content of their indigenous foods is one of the nutritional conditions to which Eskimos have adapted. Recent research on animals has elucidated the adaptive mechanisms by which calcium can be more efficiently absorbed from the food supply and retained in the skeleton when the intake is low.

X-ray examinations have indicated that adult Wainwright Eskimos are unusually prone to osteoporosis, a disease in which the bones become extremely fragile because of undue resorption of bone tissue. Low-calcium, high-phosphorus diets have induced this disease in mature experimental animals. Since the native Eskimo diet is of this type, it may accelerate the normal processes of bone resorption in adults. This question is now being investigated.

Effects of acculturation

Western dietary habits are making rapid inroads in Eskimo communities. At the same time there has been a steady increase in the incidence of metabolic diseases associated with industrial societies: cardiovascular disease, diabetes, hypertension, and tooth decay. The unique character of the native diet is slowly disappearing along with many other cultural trademarks. It is by no means clear that, at least as far as nutrition is concerned, these changes are for the better.

How Nitrogen Rates Affect Nutrient Content Of Corn Plants, as Measured in Two Ways

W. M. WALKER and T. R. PECK

THE COMPLEX interrelationships between applied fertilizers, nutrient content of the crop, and subsequent yield have inspired a great deal of research. In most of this research, nutrient concentration in the plant or some plant part has been used to represent the nutrient content of the crop.

But is nutrient concentration the best criterion to use? Would the total amount of nutrient in the crop, rather than concentration, offer a better clue to the plant analysis-yield puzzle? These questions were asked as part of a recent study to measure the effect of nitrogen fertilizer on plant composition and to investigate possible relationships with corn yields.

Corn samples were obtained in 1970 from an Agronomy Department fertilizer rate study at the Kewanee Research Field in northwestern Illinois. Four rates of nitrogen had been applied broadcast and disked in before corn planting in early May. (No nitrogen was applied to control plots.)

Whole plant samples were obtained at two stages of development — when the average height of the corn was about 30 inches, and when the corn was tasseling. Since corn plants are quite large by early tassel, the plants in the second sample were separated into six parts for subsequent chemical analysis: lower leaves, mid-leaves, upper leaves, lower stalk, upper stalk, and a composite consisting of mid-stalk, tassel, and silk.

After being dried, weighed, and ground, the samples were analyzed in the Agronomy Department Plant Analysis Laboratory. Analysis was made for 10 nutrients: nitrogen, phosphorus, potassium, calcium, magnesium, boron, copper, iron, manganese, and zinc.

Table 1. — Effect of Nitrogen Rate on Nutrient Content of Corn Plants About 30 Inches Tall; Expressed as Total Pounds in 20,000 Plants per Acre and as Concentration in the Plant

Nutrient	Nitrogen rate, lb. per acre									
	0		80		160		240		320	
	lb.	pct.	lb.	pct.	lb.	pct.	lb.	pct.	lb.	pct.
Nitrogen	14.70	2.42	29.80	3.04	27.50	3.05	29.90	3.10	34.10	3.15
Phosphorus	1.44	.24	2.39	.26	2.39	.24	2.36	.24	2.40	.22
Potassium	19.60	3.44	31.60	3.10	35.00	3.84	39.30	4.04	44.80	4.10
Calcium	2.80	.47	4.80	.49	4.30	.48	4.30	.45	4.40	.40
Magnesium	1.59	.27	3.31	.35	2.47	.28	2.27	.24	2.12	.20
	lb.	ppm	lb.	ppm	lb.	ppm	lb.	ppm	lb.	ppm
Manganese	.020	40	.050	53	.050	56	.040	40	.060	57
Iron	.100	148	.200	198	.170	185	.190	192	.200	185
Zinc	.020	34	.040	44	.040	42	.040	37	.060	52
Boron	.015	28	.022	23	.023	27	.020	20	.024	22
Copper	.006	10	.012	12	.013	14	.015	16	.011	10
Yield, bu/A.	118		146		139		153		156	

Relationships at first sampling

Table 1 shows the effect of nitrogen rate on nutrient content of corn about 30 inches tall, and also on subsequent yield. Nutrient content is expressed both as total amount (pounds per acre) for a plant population of 20,000 plants per acre, and as concentration in terms of percent or parts per million.

As would be expected, corn yields increased with increasing rates of nitrogen. Increases were also noted in the concentrations of nitrogen and potassium in the corn plant and the total amounts of these nutrients. The effect of nitrogen rate on phosphorus content was largely reflected in total uptake due to larger plant size. Concentration of phosphorus remained relatively constant.

Second sampling

In Table 2, nutrient content at the early tassel stage is expressed as the total amount in a plant population of 20,000 per acre.

Total amounts of nitrogen, phosphorus, and potassium generally increased with increasing rates of fertilizer nitrogen. At the early tassel stage, the corn plant has obtained about one-half of the nitrogen required to reach maturity (at a yield level of 150 bushels an acre), one-third to one-half of its phosphorus requirement, and three-fourths of its potassium requirement.

Calcium, magnesium, manganese, and iron contents were not consistently affected by nitrogen rate. Nitrogen rate did affect zinc content, but did not have a great effect on boron or copper.

The effect of nitrogen rate on the nutrient concentration in various plant parts at the early tassel stage is shown in Table 3. The percentage of nitrogen in all plant parts generally increased with increasing rates of nitrogen. At all except the highest rate, the upper leaves were higher in

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In this study, concentrations of the micronutrients are expressed in terms of parts per million (ppm). How small is 1 ppm? In a distance of 16 miles, it is about 1 inch. In 12 days' time, 1 ppm is about 1 second; and in 2 years' time, it is about 1 minute. It takes 10,000 ppm to equal 1 percent. Thus, if we see in Table 1 that a 30-inch tall corn plant contains 40 ppm of manganese, this is still only 0.00004 percent.

nitrogen than the lower leaves, and the upper stalk was higher than the lower stalk.

Increasing the level of fertilizer nitrogen generally increased the level of phosphorus in the corn leaves, but had a variable effect upon the phosphorus content of the stalk. Upper leaves were somewhat higher in phosphorus than the lower leaves.

The percentage of potassium in the lower stalk increased with increasing rates of nitrogen. A similar pattern was followed in the upper stalks, except that potassium percentage declined at the highest nitrogen rate. Levels of soil potassium were high (over 400 pounds an acre); thus, the potassium supply would not be expected to limit yield at any of the nitrogen rates. Average levels of potassium were lower in the stalk than in the leaves.

There was little variation in calcium or magnesium that could be attributed to nitrogen rates. Generally, calcium and magnesium contents increased from the upper to the lower leaves. Calcium concentrations were higher in the leaves than in the stalks, but magnesium concentrations in the leaves and stalks were comparable.

The manganese content of various plant parts was apparently not affected by nitrogen rates, and stalks did not greatly differ from leaves. The iron content of the stalk and leaf parts was not significantly affected by nitrogen rate, but leaves had more iron than stalks, and lower leaves had somewhat more than upper leaves.

The zinc content of all plant parts generally increased with increasing rates of nitrogen, although there was some variability in the effect of specific rates. Upper leaves generally contained more zinc than lower leaves, and leaves contained more than did stalks.

No consistent pattern was observed for the effect of nitrogen on the boron and copper contents of stalks and leaves. Leaves contained more of these elements than the stalks did.

Neither method superior

According to preliminary results, we cannot say that total nutrient uptake by the plant is a better diagnostic tool than chemical concentration. However, the question is still being studied as is the whole problem of the relationship existing between applied fertilizers, nutrient content of the plant or plant parts, and yield.

Table 2. — Effect of Nitrogen Rate on Nutrient Content of Corn Plants at Early Tassel

Nutrient	Nitrogen rate, lb. per acre: 0	80	160	240	320
	lb. per 20,000 plants				
N....	55.00	91.00	94.00	96.00	109.00
P....	5.40	8.90	8.30	9.10	13.80
K....	95.00	103.00	117.00	141.00	154.00
Ca...	20.00	23.00	27.00	23.00	24.00
Mg...	11.00	15.00	17.00	14.00	15.00
Mn...	.17	.20	.23	.18	.35
Fe...	.50	.56	.58	.60	.57
Zn...	.08	.13	.16	.12	.22
B....	.05	.06	.08	.06	.08
Cu...	.03	.03	.04	.04	.06

Since concentrations of some chemical elements vary in different parts of the corn plant, it is extremely important that we know more about these variations. Farmers and agricultural workers using plant analysis as a diagnostic tool need to recognize these differences if they are to interpret results accurately.

Table 3. — Effect of Nitrogen Rates on Nutrient Composition of Different Parts of the Corn Plant

N rate, lb./A.	Lower leaves	Mid-leaves	Upper leaves	Upper stalk	Lower stalk	Lower leaves	Mid-leaves	Upper leaves	Upper stalk	Lower stalk
	Nitrogen, pct.					*Manganese, ppm*				
0	2.14	2.36	2.50	0.72	0.42	47	40	37	50	24
80	2.53	2.81	3.01	0.96	0.62	42	40	34	48	30
160	2.62	3.02	2.94	0.92	0.80	46	47	42	56	31
240	2.88	3.21	3.16	0.95	0.92	51	44	44	48	24
320	3.16	3.26	3.10	1.04	1.06	84	61	55	72	38
	Phosphorus, pct.					*Iron, ppm*				
0	0.15	0.18	0.20	0.13	0.04	192	163	151	109	53
80	0.20	0.23	0.24	0.16	0.06	166	174	136	55	54
160	0.22	0.26	0.26	0.14	0.05	170	162	172	54	60
240	0.24	0.30	0.30	0.16	0.06	184	181	175	60	59
320	0.28	0.29	0.30	0.22	0.06	193	177	146	48	46
	Potassium, pct.					*Zinc, ppm*				
0	2.80	2.22	2.17	1.73	1.49	18	22	29	20	8
80	2.31	2.18	1.80	1.80	1.46	25	27	33	25	9
160	2.76	2.44	2.48	1.90	1.56	32	36	38	30	12
240	3.02	2.55	2.18	2.00	2.30	25	32	40	22	7
320	2.78	2.62	2.38	1.71	2.44	48	40	46	52	17
	Calcium, pct.					*Boron, ppm*				
0	0.80	0.66	0.56	0.32	0.30	12	12	20	10	7
80	0.70	0.57	0.50	0.32	0.29	11	14	14	10	6
160	0.78	0.68	0.60	0.36	0.36	16	18	18	9	8
240	0.74	0.68	0.58	0.32	0.28	13	15	26	10	6
320	0.77	0.50	0.50	0.31	0.30	18	16	26	12	8
	Magnesium, pct.					*Copper, ppm*				
0	0.27	0.24	0.18	0.22	0.20	10	10	12	4	4
80	0.28	0.22	0.18	0.24	0.26	8	9	8	6	3
160	0.29	0.26	0.20	0.23	0.27	13	14	14	6	4
240	0.26	0.24	0.20	0.22	0.24	12	14	14	6	4
320	0.27	0.20	0.16	0.22	0.28	13	14	15	6	6

Extension Programs In Agricultural Production and Marketing Focus On People's Needs

E. E. GOLDEN

BACK in 1914, W. G. Eckhardt, the first farm adviser in Illinois, said, "People like Extension because it helps the rich and poor alike." Now, six decades later, this same philosophy and the philosophy of helping people help themselves are being copied around the world.

As in the past, many Illinois residents continue to look to the Cooperative Extension Service as a source of information that will help them make decisions. Through its educational programs based on research results, Extension has made significant progress in agriculture, home economics, 4-H and youth programs, and community resource development.

Production and marketing

Extension has always given high priority to agricultural production and marketing because that is where the problems and needs were readily identified. Some observers have expressed a belief that Extension has spent too much time on production and not enough on marketing. But both are part of the same coin — production on one side and marketing on the other.

Farmers have a high ability to apply production techniques and information presented through Extension demonstrations, talks, and other educational programs. New production problems — such as the one created by southern corn leaf blight — force Extension programs to be flexible and advisers to be ever alert. With population increases and changes in technology, the jobs of Extension and farming become more crucial every day.

The Illinois Extension Service will continue to offer educational programs on the technology and economics of producing food and fiber. Some programs will provide new knowledge on livestock, dairy, poultry, and crop production. Others will deal with the economics of operation as well as the investment requirements for buildings and machinery, herbicides, insecticides, and fertilizer applications. Still others will concern soil and water and a myriad of related problems such as erosion and pollution.

A look at the marketing side of the coin reminds us that, within the memory of many farmers, the marketing of farm products has come full circle. First, farmers sold to local buyers; then they began shipping and selling through commission men in terminal markets; now they are again selling directly to buyers.

Marketing itself means "all business activity involved in the moving of goods from the producer to the consumer." While much work is needed in marketing, it is fairly efficient. Often it is much easier to market 10,000 bushels of corn than to produce it.

While production is usually only farm-wide, marketing is often worldwide. Illinois is the nation's leading agricultural exporting state, having sold more than $655 million worth of agricultural commodities abroad last year.

In the future, Extension will offer programs to help both producers and industry understand problems of product quality, market organization, business management, outlook, and general market trends. Some programs for producers will reflect the demand for quality and the current trends in consumer preference. A coordinated marketing system is developing and this calls for programs that will deal with changes in market outlets, transportation facilities and costs, processing, merchandising, and the products themselves. Producers, consumers, and marketing firms also want an understanding of the long-run and short-run effects of trends in production, prices, market outlets, and government programs.

Four major problems

Many other problems face Illinois farmers today. Some of the biggest ones, however, involve policy and economic forces beyond the control of any one individual. Extension advisers in agriculture have identified four issues that they consider to be of major concern to farmers:

1. As agriculture continues to change, how can the farmer get his fair share of the economic growth and profits?
2. What is the emerging production system in agriculture?
3. What is the evolving marketing system for agriculture products?
4. Who will control agriculture?

In the future, Extension will help local leaders to develop programs on these four problems. Already the University of Illinois Cooperative Extension Service has been asked to provide leadership in developing a regional North Central Extension program on the last of the above questions. The purpose of the program is to describe and assess (1) the potential and prospects for alternative policies that will affect the future control of U.S. agriculture, and (2) the consequences for farmers, supply and marketing firms, the rural community, and consumers.

Extension goals

Our ultimate goal for Extension is to help achieve an agricultural economy that is: (1) technologically sound, (2) economically satisfying, (3) environmentally responsible, (4) organizationally strong, (5) family-oriented, and (6) community-minded. With the pride in Extension that started with such farm advisers as Eckhardt, we intend to develop programs that will stay close to the cutting edge of people's needs and concerns.

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Job Opportunities for the Recent Graduate

WARREN K. WESSELS

Percentages of Agriculture Graduates Going Into Various Occupations Right After Graduation, 1968-1972

Type of occupation	1968	1969	1970	1971	1972
			percent		
Graduate and professional study	25	24	28	23	15
Military service	30	24	15	20	6
Agricultural business and industry	17	21	18	21	26
Farming	7	11	11	17	21
Educational work	5	5	6	2	3
U.S. government	6	4	3	2	2
Miscellaneous	7	8	5	1	9
Undecided and no information	3	3	14	14	18

MORE College of Agriculture graduates are going back to the farm right from college than was true four years ago. Other shifts have also occurred in the plans of graduating seniors from 1968 to 1972.

The job choices available to graduates in 1971 and 1972 just did not compare with the job market in the mid-1960's, when three or four employment opportunities awaited every graduate in agriculture and other curricula as well.

Despite the tightness of the job market in 1972, the majority of the graduates did find work. And the starting salaries were generally higher this year, ranging from $7,000 to $10,000 and averaging $8,680. Average starting salary in 1968 was $7,524.

The table on this page indicates the kind of employment that College of Agriculture graduates entered immediately upon leaving the university in the years from 1968 through 1972.

The decrease in the percentage entering military service is to be expected since military requirements have been sharply reduced. The tightness of the job market at the M.S. level in certain areas, as well as the reduction of budgets for some graduate programs, has been responsible for fewer numbers enrolling in graduate and professional programs.

The number of students entering governmental employment has also been decreasing. Many federal agencies — including the Soil Conservation Service, the U.S. Forest Service, Farmers Home Administration, and other allied agencies — are hiring very few new people. The percentage of graduates going into teaching at the secondary level has declined slightly.

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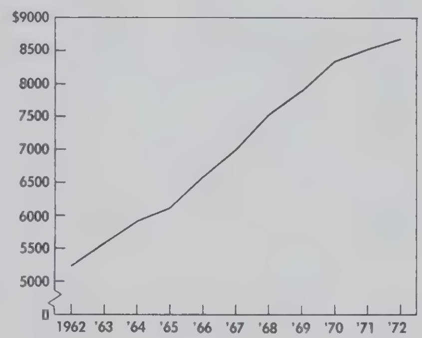
As a result of all these changes, more agriculture graduates are entering agricultural business and industry, are going into miscellaneous occupations, or are returning directly to the farm.

Many and varied job opportunities in business and industry still awaited the 1972 graduate. For example, a strong demand existed for graduates in the fields of banking, credit, and farm management. Grain marketing and commodity work also offered opportunities. The seed, feed, plant food, and agricultural chemical industries continued a steady demand for graduates, as did the food and meat packing industries. After a period of slight demand, the farm equipment industry was again seeking new graduates. Some graduates found jobs in nursery production and in forest products industries.

The Peace Corps, religious organizations, the building and construction industry, and newspapers provided most of the job opportunities grouped under "miscellaneous."

The higher percentage going into farming in 1972 than in 1968 can be partly explained by the fact that many young men used to work in industry for three to five years before returning to the family farm. Now more are exercising their option of returning to farming immediately upon graduation. Nearly all of these



Starting salaries of College of Agriculture graduates, 1962-1972.

young men return to "built-in" farming operations with ample opportunity for expansion.

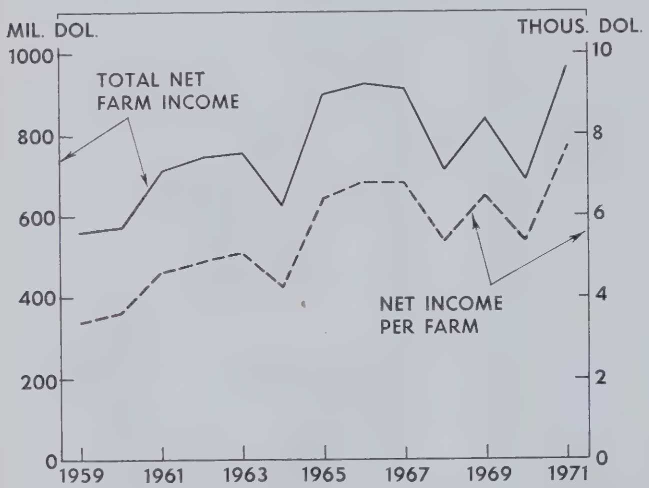
At commencement time, 18 percent of the graduates fell into the category of "undecided or no information." This "in limbo" situation resulted from the fact that employers are more deliberate and are not making commitments about employment as early as they formerly did.

A strong demand still exists for young people with a background in agricultural business and industry and a desire to enter sales and management. The agriculture segment of our economy is not as vulnerable to rapid change as is, for example, the aerospace industry. We can therefore be confident that excellent opportunities will continue to be available to those who prepare themselves with a college degree in agriculture.

FARM BUSINESS TRENDS

Illinois farm income fluctuates considerably from year to year, as shown by the chart on this page. The chart also shows that state farm income increased markedly from 1959 to 1967, but that the three years 1968-1970 were poor ones for Illinois farmers. There was a good gain in 1971, and there will be an even greater increase in 1972, which is not shown.

In 1964 farm income was depressed by low prices for hogs, cattle, and wheat, and by poor yields of corn and soybeans. In 1968 hog prices dropped again, and corn yields and prices were down. In 1970 Illinois was hit hard by the southern corn leaf blight, wheat yields and prices were both down, and prices for soybeans and hogs were also low.



Illinois net farm income, 1959-1971. As number of farm operators declined, net income per farm increased more than total income.

This year (1972) seems likely to be exceptionally good. The large wheat crop is selling at good prices. Soybean production and prices are both up from last year. A large part of the big 1971 corn crop was held over for sale this year, and prices of corn rose sharply during the summer. Prices for both hogs and cattle have been at cyclical peaks.

As shown by the chart, total Illinois net farm income increased from $564 million in 1959 to $965 million in 1971. This income was divided among fewer farmers each year, so that the income per farm operator increased more rapidly than did the total. The income of the Illinois farm operators rose from $3,440 in 1959 to $7,780 in 1971. These figures do not include income received from off-farm sources.

The figures reported here were compiled by the U.S. Department of Agriculture, and included all farms in the state.

Looking ahead, it appears that 1973 could be another good year for most Illinois farmers. Hog prices are expected to hold up well — at least during the first three quarters. Cattle prices should average about the same as in 1972. A large part of this year's corn and soybean crops will be sold in 1973 at good prices. If Illinois farm income holds up through the coming year, we will have three good years in a row, comparable to those of 1965-67. — *L. H. Simerl, Professor of Agricultural Economics*

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